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Engineering Library

The Engineer

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PUBLIC NOTICES

Assistant Mechanical Engineer required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT for two tours, each of 12 to 18 months' service, with prospect of permanency. Salary £480 a year, rising by annual increments of £30 to £720 a year, and thereafter by £40 to £920 a year, with an outfit allowance of £60 on first appointment. Free single quarters and first-class passages. Liberal leave in England on full salary.

Candidates, age 28 to 35, must hold a First Class Board of Trade Certificate or be A.M.I. Mech. E. It is essential that they should have had good general engineering experience, including American motor cars and lorries, steam and internal combustion stationary engines, electrical and woodworking machinery.

Apply at once, by letter, stating age and giving brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/Gold Coast 10,859. 6767

H.M. Mining School, PORTSMOUTH.

ENGINEER REQUIRED, to Take Charge of Design of Ship Fittings. Salary £150-£10-£300 per annum plus Civil Service bonus. Starting salary plus present bonus £303 per annum.

QUALIFICATIONS.—Good technical training and experience in design of ship fittings; capable of designing and supervising initial manufacture and testing of these designs.

Applications for appointment to be addressed to SECRETARY OF THE ADMIRALTY (C.E.), Whitehall, S.W. 1. 6779

H.M. Mining School, PORTSMOUTH.

An ENGINEER REQUIRED for Mechanical Experiments. Salary £300-£15-£500 plus Civil Service bonus. Starting salary plus present bonus is £528 per annum.

QUALIFICATIONS.—Good university degrees or equivalent qualifications. Experience in workshop and of experimental engineering, preferably in laboratory research, with an intimate knowledge of hydraulics.

Applications for appointment to be addressed to SECRETARY OF THE ADMIRALTY (C.E.), Whitehall, S.W. 1. 6780

H.M. Mining School, PORTSMOUTH.

ENGINEER REQUIRED, to Take Charge of Design. Salary £300-£15-£500 per annum plus Civil Service bonus. Starting salary plus present bonus £528 per annum.

QUALIFICATIONS.—Sound knowledge of electrotechnics and physics; good practical experience of design of delicate electrical instruments; a natural aptitude for invention; capable of designing and initial manufacture and testing.

Applications for appointment to be addressed to the SECRETARY OF THE ADMIRALTY (C.E.), Whitehall, S.W. 1. 6781

Iron and Steel Institute,
28, VICTORIA-STREET, LONDON, S.W. 1.

ANDREW CARNEGIE RESEARCH FUND.

The COUNCIL of the IRON AND STEEL INSTITUTE is prepared to receive APPLICATIONS for GRANTS in aid of Research Work on the Metallurgy of Iron and Steel.

The number of grants in any one year is limited to 5 or 6. The Council is not pledged to accept any particular application for assistance, but will give preference to those proposals which appear to them to be of the most practical advantage to the iron and steel and allied industries.

Proposals should be submitted before the end of February, 1922, on a special form to be obtained from the SECRETARY of the INSTITUTE. 6721

Borough of Portsmouth.
MAIN DRAINAGE.—CONTRACT No. 6.
TO PIPE FOUNDERS.

The Corporation of Portsmouth is prepared to receive TENDERS for the SUPPLY of the following quantities of 42in. diameter CAST IRON PIPES, in accordance with the British Standard Specification Class "C," delivered free on rail at Fratton Railway Station, Portsmouth:—

STRAIGHT SOCKET PIPES, about 1530 Yards Lineal.

SPECIAL CASTINGS, about 80 Tons.

Form of Tender may be obtained at the office of the Engineer, Mr. G. Midgley Taylor, of John Taylor and Sons, 36, Victoria-street, Westminster, S.W. 1, upon payment of £2 (cheque only), which will be returned upon receipt of a bona fide Tender.

Forms of Tender will only be issued to bona fide pipe founders.

Sealed Tenders, endorsed "Main Drainage, Contract No. 6," addressed to the Town Clerk, are to be delivered at his office at or before 9 a.m. on Friday, 16th December, 1921.

The Corporation does not bind itself to accept the lowest or any Tender.

F. J. SPARKS,
Town Clerk.

Town Clerk's Office,
Town Hall, Portsmouth.
November, 1921. 6797

Madras and Southern Mahratta
RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for:—

(1) DUPLICATE PARTS for CARRIAGES and WAGONS (Buffers, Spindles, Castings, &c.).
(2) 430 PAIRS WHEELS and AXLES for CARRIAGES and WAGONS.
(3) 4958 HELICAL and VOLUTE SPRINGS.
(4) 114 COPPER FIRE-BOX PLATES.
(5) 21,250 STEEL BOILER TUBES.
(6) WOOD SCREWS, NAILS, TACKS, &c.
(7) BOLTS, NUTS, RIVETS and WASHERS.

In accordance with the specifications, which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, the 20th December, 1921, marked "Tender for Duplicate Parts for Carriages and Wagons," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices:
25, Buckingham Palace-road,
Westminster, S.W. 1.
23rd November, 1921. 6796

PUBLIC NOTICES

Corporation of Durban, Natal.

The Corporation of Durban, Natal, is prepared to receive TENDERS for the SUPPLY and DELIVERY c.i.f. Durban of TWO CHLORINATORS for WATER PURIFICATION.

The whole to be approved by the Representative Engineers, W. H. Radford and Son, Albion Chambers, Nottingham.

Specifications, by Mr. Walter M. Campbell, M. Inst. C.E., Water Engineer, Durban, can be obtained from, and sealed and endorsed Tenders must be delivered to the undersigned on or before 3rd December, 1921.

The lowest or any Tender will not necessarily be accepted.

By Order,
WEBSTER, STEEL and CO.,
Agents to the Corporation.
5, East India-avenue, E.C. 6758

London County Council.

TENDERS are INVITED for CENTRIFUGAL PUMPS and OIL or GAS ENGINES for a pumping station to be erected at Hammersmith. The total pumping capacity of the station will be about 1000 tons of water a minute.

Persons desiring to Tender may obtain on and after Monday, 28th November, 1921, the drawings, specifications, form of Tender, &c., on application to the Chief Engineer at the County Hall, Spring Gardens, Charing Cross, S.W., upon payment to the Cashier of the Council of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the drawings, specification and other contract documents may be inspected at the County Hall before the payment of the fee.

No Tender received after 4 p.m. on Monday, 9th January, 1922, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
6783 Clerk of the London County Council.

London County Council.

TENDERS are INVITED for the SUPPLY of 1000 and alternatively 2000 TRAILING WHEEL TYRES for Electric Tramways.

The form of Tender may be obtained from the General Manager, London County Council Tramways, 29, Belvedere-road, Lambeth, S.E. 1.

No Tender received at the County Hall, Spring Gardens, S.W., after Twelve Noon on Tuesday, 6th December, 1921, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
6784 Clerk of the London County Council.

The Bengal and North-Western
RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

30 THIRD-CLASS BOGIE CARRIAGES (without Wheels and Axles, &c.),

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned and marked "Tender for Carriages," are to be lodged not later than Noon on Monday, the 19th day of December, 1921.

For each specification a fee of £1 will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. A. NEVILLE,
Managing Director.
237, Gresham House, Old Broad-street,
London, E.C. 2.
23rd November, 1921. 6792

PUBLIC NOTICES

Metropolitan Water Board.

TENDERS FOR THE SUPPLY AND FIXING OF LANCASHIRE BOILERS, SUPERHEATER, PIPING, AND FEED PUMPS AT DEPTFORD, S.E. 8.

The Metropolitan Water Board invite TENDERS for the SUPPLY and FIXING of TWO LANCASHIRE BOILERS, SUPERHEATER, PIPING, FEED PUMPS, &c., at their Deptford Pumping Station, Brookmill-road, S.E. 8.

Forms of Tender, conditions of contract, specification, and drawing may be inspected without payment of fee at the offices of the Board, Room 162, Chief Engineer's Department, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Tuesday, December 6th, 1921.

Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of £1 1s., which sum must be deposited with the Board's Accountant and will be returned on receipt of a bona fide Tender, together with all incidental papers.

Such payments and applications must be made between the hours of 10 a.m. and 4 p.m., Thursdays excepted (Saturdays, 10 a.m. to 12 noon).

Tenders, enclosed in sealed envelopes addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Boilers, Deptford," must be delivered at the offices of the Board not later than 10 a.m. on Wednesday, 18th January, 1922.

W. MOON,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
November, 1921. 6763

South Staffordshire Waterworks
COMPANY.
TENDER FOR THE LAYING OF 18in. AND 24in. STEEL PIPES, SOMERFORD TO BLOXWICH.

The South Staffordshire Waterworks Company invite TENDERS for the LAYING and JOINTING of about 16,000 LINEAL YARDS of STEEL WATER MAIN, 18in. and 24in. in diameter, from their intended Pumping Station at Somerford, in the Parish of Brewood, to Bloxwich, both in the County of Stafford, together with contingent works.

Forms of Tender, specification, bill of quantities, and schedule may be obtained from, and drawings inspected at, the offices of the Engineer-in-Chief on and after November 21st, 1921, between the hours of 10 a.m. and 4 p.m. daily, Saturdays excepted, upon the deposit of a cheque value Five Guineas, which will be returned on receipt of a bona fide Tender, together with the return of all documents supplied.

Sealed Tenders, endorsed "Tender for Somerford-Bloxwich Main," must be delivered to the undersigned not later than 10 a.m. on Monday, December 12th, 1921. The Company do not bind themselves to accept the lowest or any Tender.

FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.
26A, Paradise-street, Birmingham,
November, 1921. 6699

The Assam-Bengal Railway
COMPANY, Limited, is prepared to receive TENDERS for:—

COVERED GOODS WAGONS.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 90, Bishopsgate, E.C. 2. A fee of £1 1s. is charged, which cannot under any circumstances be returned.

Drawings may be had at the cost of the tenderer by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.

Tenders must be delivered at the Company's Offices not later than Noon on Wednesday, the 14th December, 1921.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
OSWALD I. MILNE,
6766 Secretary.

PUBLIC NOTICES

The Commissioners for the Port OF RANGOON.
60-TON FLOATING CRANE ON A SELF-PROPELLING PONTOON.

TENDERS are INVITED for the above PLANT, completely delivered, erected, and ready for work, in the Port of Rangoon.

Further particulars to be obtained from the Commissioners' London Agents, Messrs. OGILVY, GILLANDERS and COMPANY, Sun-court, 67, Cornhill, London, E.C. 3 6785

The Guardians of the Poor of the Parish of Lambeth hereby invite TENDERS for the EXECUTION of ALTERATIONS to the WATER SOFTENING PLANT at their Workhouse, Kennington. Printed forms of Tender, together with specifications (which alone will be received), may be obtained at this office any day (except Saturday) between the hours of 10 a.m. and 5 p.m., and must be returned in a sealed envelope superscribed "Tender for Water Softening Plant," addressed to the undersigned, or placed in the box provided for the purpose in the office of the Clerk to the Guardians, by the tenderers or their representatives, should they so desire, not later than the first post on Tuesday, the 13th proximo.

The Guardians do not pledge themselves to accept the lowest or any Tender.

By Order,
JAMES L. GOLDSPINK,
Clerk to the Guardians.
Guardians' Offices and Board Room,
Brook-street, Kennington-road, S.E.,
23rd November, 1921. 6815

The Great Indian Peninsula
RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

No.		Fee for Specification.
1.	STEEL SCREW COUPLINGS	£1
2.	WICKS, LUBRICATING PADS, &c.	10s.
3.	DRAWN BRASS ANGLES, &c.	7s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Steel Screw Couplings," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 6th December, 1921.

The Directors do not bind themselves to accept the lowest or any Tender.

B. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 23rd November, 1921. 6793

The Maldens and Coombe Urban DISTRICT COUNCIL.
TO ENGINEERS AND BUILDERS.

The Council invite TENDERS for the PROVISION of STEAM PUMPING MACHINERY at the Sewage Works, California-road, New Malden, as follows:—

CONTRACT No. 1.—Comprising the Supply and Erection of a 14/28 B.H.P. Steam Engine with Pulleys and Friction Clutch, &c.

CONTRACT No. 2.—Comprising the Supply and Erection of a 10in. Horizontal Steam-driven Sludge and Water Pump, and Fixing existing 5in. Ruston Centrifugal Pump and necessary Suction and Delivery Pipes, &c.

CONTRACT No. 3.—The Supply and Erection of a Superheater and necessary 4in. Steam Piping, Valves, &c.

CONTRACT No. 4.—Comprising the Builders' Work in connection with forming new Concrete Floor, Alterations to Boiler Flues, Cutting Holes, &c.

The plans and general conditions may be inspected and copies of the specification, estimate, and form of Tender can be obtained on application to the Engineer and Surveyor, Mr. Reginald H. Jeffs, A.M.I.C.E., at the Municipal Offices, New Malden, between the hours of 9 a.m. and 5 p.m. (Saturdays, 9 a.m. to 1 p.m.) upon payment of a deposit of Two Guineas per contract, which shall be by cheque made payable to the Council. The deposit will only be returned on receipt of a bona fide Tender accompanied by the specification, estimate, &c., attached, and in the case of the accepted Tender the deposit will be retained until a contract and bond have been entered into with the Council, and in the event of a withdrawal such sum shall be forfeited.

Sealed Tenders, properly endorsed, must be received by the undersigned not later than 4 p.m. on Tuesday, the 13th December, 1921.

The Council do not bind themselves to accept the lowest or any Tender.

JAMES W. JOHNSON,
Clerk of the Council.

Municipal Offices,
New Malden, Surrey,
18th November, 1921. 6755

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PUBLIC NOTICES

The Manager of the Dublin and BLESSINGTON STEAM TRAMWAY COMPANY is prepared to receive TENDERS for the SUPPLY of LUBRICATING OILS, WASTE, RAGS, BOLTS and NUTS, BRASSES, IRON, FILES, FIRE-BRICKS, RIVETS, PERMANENT WAY FASTENINGS, SPRINGS, CREOSOTE OIL, PAINTS and VARNISHES, SLEEPERS, STEEL, TIMBER, PACKINGS, SCREWS, NAILS, GLASS, COPPER, &c., from 1st January to the 31st December, 1922.

Samples may be seen at the Company's Offices, Templeogue.

Contractors cannot be allowed to tender to supply goods to their own samples, but the articles tendered for must be in every way up to the standard of the sample shown by the Company.

All Tenders must be sent in on the Company's forms (which can be obtained from the Secretary on payment of 6d. each), marked "Tender for Stores" and addressed to the Secretary so as to be with him on or before the 10th December, 1921.

The Manager does not bind himself to accept the lowest or any Tender.

H. O. TISDALL,
Secretary.

Terenure, County Dublin.
12th November, 1921. P4455

The South Indian Railway Com- PANY, Limited, are prepared to receive TENDERS for the SUPPLY of :—

(1) ROLLING STOCK : 100 Broad-gauge Steel-covered Goods Wagons.

(2) SPRINGS : Laminated, Volute and Helical Springs for the above wagons.

Specifications and forms of Tender are available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Rolling Stock," or as the case may be, must be left with the undersigned not later than Noon on Wednesday, the 14th December, 1921.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 25s. for each copy of the Specifications Nos. 1 and 2.

Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 2, Victoria-street, Westminster, S.W. 1.

W. R. REYNOLDS,
For Managing Director.

91, Petty France, S.W. 1.
23rd November, 1921. 6809

Metropolitan Borough of Wool- WICH.
ELECTRICITY DEPARTMENT.
DISPOSAL OF TINS REMOVED FROM HOUSE REFUSE.

The Council of the above Borough invite OFFERS for the REMOVAL of the whole of the TINS and OLD IRON, &c., collected from house refuse and now lying at the Plumstead Refuse Destructor Station, White Hart-road, Plumstead, S.E. 18.

The whole of the present deposit to be cleared within 6 weeks of acceptance of offer. The Council will also consider offers for periodical clearance in addition.

Offers should be endorsed "Removal of Tins," be sealed and addressed to the Borough Electrical Engineer, Town Hall, Woolwich, S.E. 18, not later than the 1st December next.

By Order,
ARTHUR B. BRYCESON,
Town Clerk.

Town Hall, Woolwich, S.E. 18.
22nd November, 1921 6800

Bombay Port Trust. The Trustees invite APPLICATIONS from Engineers possessing experience in Port, Dock, and Railway Construction and Maintenance for APPOINTMENT as their CHIEF ENGINEER.

The salary of the officer selected will be determined according to qualifications and experience.

The present salary of the appointment is Rs. 2750, rising by annual increments of Rs. 125 to Rs. 3000.

Under the Trustees' rules married officers are provided with house accommodation, for which rent at the rate of 10 per cent. of salary is charged.

Applications should be addressed in writing to the Consulting Engineers and Agents, Bombay Port Trust, 2, Queen Anne's-gate, S.W., and will be received up to the 1st December, 1921. These should be accompanied by a complete resume of applicant's professional career and copies of not more than three recent testimonials.

Age (preferably between 40 and 45 years) should be stated.

By Order of the Trustees,
A. J. BARRY,
WALTER C. HUGHES,
K. A. WOLFE BARRY,
Consulting Engineers and Agents.

14th November, 1921.
Dartmouth House,
2, Queen Anne's-gate,
Westminster, London. 6795

Singapore, Straits Settlements. WATER DEPARTMENT.

The Municipal Commissioners of Singapore REQUIRE TWO ASSISTANT ENGINEER-DRAUGHTSMEN, unmarried, age 25-35, on a three years' agreement, with possible extension. They must have a good education, a good training in a civil engineer's office, and must have a practical knowledge of surveying, levelling, and draughtsmanship, preferably with experience in the design and construction of new waterworks and appurtenant works and buildings. They would be employed chiefly on the design of waterworks, and would work under the instructions of assistant engineers. Salary, 5400 dollars for the first, 5880 dollars for the second, and 6360 dollars for the third year, paid monthly in dollars, the currency of the Colony, the value of the dollar being fixed at 2s. 4d. sterling. The pay of the appointment for the first year at this rate would be £650. In addition, there is, at present, a temporary allowance of fifteen per cent. on the salary, which is subject to revision at any time. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passages will be provided, with half pay during the voyage out. Each of the selected candidates must pass a medical examination.—Applications, stating whether married or single, age, and place of birth, and giving details of education, training and experience generally, and in waterworks particularly, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials, and two personal references, to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 13th December, 1921. 6765

Watford Urban District Council. SERVICE RESERVOIR.
APPOINTMENT OF CLERK OF WORKS.

The Watford Urban District Council invite APPLICATIONS for the APPOINTMENT of a CLERK of WORKS for the Construction in Concrete of a Two Million Gallons Service Reservoir and Pipe Lines.

Candidates must be thoroughly qualified by actual experience in the supervision of similar work. They must have a sound practical knowledge of materials, construction, setting out, and in the testing of cement.

The Clerk of Works appointed will be required to be on the works during all working hours.

The salary will be £5 per week, paid monthly.

Applications, endorsed "Clerk of Works," stating age, experience, when at liberty, and accompanied by three testimonials, to be delivered to the undersigned not later than Wednesday, 14th December, 1921.

W. HUDSON,
Clerk and Solicitor.

Council Offices, Watford. 6796

SITUATIONS OPEN

WANTED, Thoroughly Experienced SALES MANAGER, to Take Complete Charge of the Concrete Mixer Department of a well-known firm of Engineers; must have good connection and be an energetic salesman. All particulars in confidence, stating salary required.—Address, 6739, The Engineer Office. 6788 A

SITUATIONS OPEN (continued)

WANTED, a TECHNICAL and PRACTICAL ENGINEER as Assistant to a Consultant. By preference a Wh.S. or a University Graduate with an engineering degree, but experience in high efficiency steam raising and power plants a necessity.

An energetic man of about 30 years of age is desired, and the position is one of promise to the right man.

Address, 6813, The Engineer Office. 6813 A

WANTED, a TIME STUDY MAN and RATE FIXER. Applicant must be accustomed to taking accurate elementary time observations and to fixing rates for machining and erecting of parts for prime movers using steam and oil in medium-sized Midland engineering works. American experience desirable. Give full details experience, age, and salary required.—Address, 6778, The Engineer Office. 6778 A

CEMENT WORKS, INDIA.

WANTED, an ASSISTANT GENERAL MANAGER, for large Cement Works in India, qualified Engineer, with a complete knowledge of the manufacture of Cement (wet process); three years' agreement, free unfurnished quarters.—Write, giving full particulars of experience and salary required, to Z. S. 982, c/o Deacon's, Leadenhall-street, London. 6791 A

WANTED, Thoroughly Qualified and Up-to-date WORKS SHOPS ENGINEER, to Take Charge of Foundry, Pattern Shop, Smith and Boiler Shop, and thoroughly modern up-to-date machine tools employed on light and heavy general repairs and productions. Must be good and efficient organiser, well accustomed to the handling of men.

Applicants to give full particulars of experience, age and salary.

Address, 6810, The Engineer Office. 6810 A

A BRITISH FIRM of MERCHANTS REQUIRE an ENGINEER, with managing experience on the commercial and selling side, to Take Charge of Branch Department in the Far East. Must have had workshop training and be qualified technically.

Applicants must be energetic and good organisers, competent to direct and control staff both of technical salesmen and office men. Essential physically fit for residence in the tropics.

Preference given to unmarried man of 33 to 40.

State age, qualifications, experience, and salary expected.

Address, P4432, The Engineer Office. P4432 A

A VACANCY OCCURS in a Large Engineering Works for an EXPERT FOUNDRYMAN, who would be required to act as a connecting link between the drawing-office, pattern shop and ironfoundry. Applicants must prove a first-class practical experience of up-to-date foundry practice, and be able to discuss matters of design, &c., with engineers and draughtsmen. The position is an attractive one, and offers great scope to a really capable man. Applications (which will be treated in confidence) should give full particulars of training and experience, positions held, age and salary required.—Address, 6711, The Engineer Office. 6711 A

CHIEF RATE FIXER WANTED for Large Engineering concern in the North of England: applicants must be well acquainted with the Working of Piecework Systems, capable of Supervising a large staff of Rate Fixers, and well experienced in Machining and Assembling Operations. Only really first-class men who have held similar positions elsewhere need apply. State experience (fully), age and salary required.—Address, 6710, The Engineer Office. 6710 A

COMMERCIAL ENGINEER.—VACANCY Shortly occurring in India for capable, energetic MANAGING ENGINEER for European firm dealing in machinery. Bachelor essential, age 30-35; previous experience in the East necessary; passage out and home, salary, commission, three years' agreement.—Reply, with full experience of training and experience, to Box No. C.E. 1930, c/o Advertising Offices, 131, Cannon-street, London, E.C. 4. 6761 A

PUBLICITY DEPARTMENT of Large Engineering Firm REQUIRE the SERVICES of a first-class MAN to Supervise the Preparation of Catalogue in connection with Light Railway Stock. State age, salary expected, and when at liberty.—Address, Box 63, Wheeler's Advertising Agency, Manchester. P4441 A

REQUIRED by Old-established Engineering Company in India, thoroughly trained and educated TECHNICAL ENGINEER, age 22/25, single, with university degree, B.Sc. preferred. Office experience in addition would be a recommendation.—Reply fully, stating age, salary expected, and experience, to Z. A. 947, c/o Messrs. Deacon's, Leadenhall-street, London, E.C. 3. 6741 A

REQUIRED, INSPECTING ENGINEER for Continental, thoroughly experienced in the Inspection and Tests of important Steel Castings and Forgings, Structural and Miscellaneous Materials. Knowledge of German language essential. Applicants must give complete record of their experience, also state age and salary required.—Address, 6803, The Engineer Office. 6803 A

RUBBER WORKS REQUIRE REPRESENTATIVES on commission only, with good connection for selling patent C.T.S. packing. Liberal terms to suitable people.—Write, ST. HELENS CABLE and RUBBER CO., Ltd., Warrington. 6802 A

SOUTH LONDON FIRM REQUIRES the SERVICES of CONSULTING ENGINEER for monthly inspections of small plant, lifts, &c. &c., and to advise from time to time on renewals and improvements.—Write, giving references, to Box 276, Smith's Agency, Ltd., 100, Fleet-street, E.C. 6776 A

TECHNICAL and COMMERCIAL ASSISTANT, with ultimate promotion, for department handling a specialty in non-corrodible metals. Good opportunity and prospects for capable technically trained man. State experience and give references.—Address, "TECHNICAL," Wm. Porteous and Co., Advertising Agents, Glasgow. P4661 A

TESTER, with Thorough and Extended Experience in Testing Steam, Petrol, and Electrically Driven Centrifugal Pumps. Enclose full details of experience and state age, wage, &c.—Address, 6751, The Engineer Office. 6751 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the SERVICES of a WORKS MANAGER for their Reinforced Concrete Pipe Works. Qualifications primarily ability to handle men, with some knowledge of concrete.—Reply in writing to above. 6814 A

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For continuation of Small Advertisements see page iii

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Japanese Naval Construction.

THE fact that Japan as a naval Power is now inferior only to ourselves and the United States forms the subject of a great deal of comment both here and across the Atlantic. It has drawn unusual attention to the financial and political aspects of Japanese naval policy, and was undoubtedly one of the main reasons why the American Government convoked the present Conference. At first sight there seems little enough justification for this sudden interest, not to say apprehension, regarding the naval developments which have been taking place in the Far East. Reckoning only such ships as are now in service, the Japanese Navy does not appear to be particularly formidable in comparison with the navies of Great Britain and the United States. Its elevation to the rank it occupies to-day is due much more to fortuitous circumstances than to any efforts put forward by the Japanese themselves. Had not the war intervened, Japan might still be fourth, perhaps even fifth, in order of naval precedence, for her existing fleet is considerably smaller than that which Germany possessed at the outbreak of hostilities. Moreover, the programme that France had in hand in 1914 would doubtless have been completed in the normal course of events, in which case the French Navy would now be stronger in battleships than the Japanese. The really significant factor in the situation is not the amount of naval tonnage which Japan has already built, but the amount which she has on order or proposes to build. This is so large that its completion would approximately double her present fighting strength at sea. On October 1st of the current year, the Japanese Navy included only 7 completed Dreadnought battleships and 4 battle-cruisers. The corresponding figures were, for the United States, 20 battleships and for Great Britain, 22 battleships and 7 battle-cruisers. Therefore against a total of 20 American or 29 British all-big-gun ships, Japan could muster only 11. Had there been no reason to anticipate any drastic alteration in this ratio, the present discussion with regard to Japanese naval policy would be irrelevant and uncalled-for. It is only when we turn to the statistics of tonnage building or authorised that we begin to appreciate the magnitude of Japan's naval preparations. Her avowed purpose—now presumably to be modified—was to create a first-line fleet of two squadrons, one comprising 8 battleships and the other 8 battle-cruisers—or 16 capital ships in all. Of the vessels already completed, only two were deemed worthy of inclusion in this so-called "eight-eight fleet"; which means that the remaining fourteen units have yet to be completed. It will therefore be seen that the 11 capital ships now in commission represent numerically less than half the establishment contemplated, which would ultimately have stood at 25 ships, 16 of which were to be of the largest and most powerful type. The date on which this maximum degree of strength was to be attained was March, 1928. Besides the capital ships enumerated, provision had been made for 12 cruisers, 32 destroyers, 5 gunboats, 18 fleet auxiliaries, and "a certain number" of submarines—all of which were additional to construction voted previous to July, 1920. According to an Admiralty statement in the House of Commons on December 1st, 1920, Japan had on hand at that time the balance of an old programme due for completion in 1923–24, the residue of which included 11 cruisers and 41 destroyers.

We are not concerned with the political aspect of this great shipbuilding scheme, but some brief comments on the financial burden its execution would have entailed may not be out of place. The following table* shows the credits which have been or were to be voted year by year *for new construction alone*, as distinct from other naval services, during the period covered by the programme now in force:—

	£
1920–21	23,189,233
1921–22	27,330,135
1922–23	20,092,565
1923–24	15,473,463
1924–25	10,981,144
1925–26	11,205,479
1926–27	11,369,285
1927–28	11,537,735

This gives a total of £131,179,039 to be spent on new naval tonnage in the space of eight years. It is an imposing sum as it stands, the expenditure of which would strain the resources of a State much wealthier than Japan. Nevertheless, it is already evident that if the programme had been carried out in its entirety the above estimate would have had to be revised on the upward scale. It was framed last year on the supposition that the cost of each ship would not exceed a certain figure, but it is notoriously difficult to forecast the trend of naval design even a few years ahead, and what seems an ideal type to-day may have become almost obsolete by to-morrow. The present cost of a capital ship of conventional type is probably about £7,500,000 or £8,000,000. But should anything occur to make still greater dimensions necessary or desirable, the cost per ship must inevitably rise in proportion. There is, indeed, some reason to believe that improvements made recently in the design of certain Japanese ships which were about to be laid down have upset the financial calculations on which the above table was based, and the Press of Japan takes it for granted that the building programme would eventually have cost from 20 to 30 per cent. more than the original estimate. The difficulty of appraising the annual cost of a given programme of naval construction over a long term of years has often been exemplified. Germany, in carrying out her "Flottengesetze," found it impossible to adhere to the yearly instalments originally fixed, and more recently still the United States have been compelled to make a substantial increase in the credits authorised for each and every type of ship included in the three-year Navy Law of 1916.

One striking point about the Japanese naval budget is the extraordinarily large percentage which is absorbed by new construction. This vote alone accounts for 55 per cent. of the total navy appropriations in the current year. An analysis of Japan's national income and expenditure shows that this year's vote for *new naval construction* is equivalent to 17.5 per cent. of the total revenue from taxation. Clearly, therefore, "the burden of armaments" is something more than a phrase to the taxpayers of Japan. That so large a share of the Navy Budget should be available for shipbuilding is due in part to the low cost of other branches of the service compared with foreign navies. Pay, pensions, allowances, victualling, labour charges, &c., are on a considerably lower scale than those prevailing in Europe or the United States. On the other hand, Japan probably has to pay more for building materials, machinery, armour, ordnance, and equipment, so that it is doubtful whether in the long run she gets better value for her naval expenditure than other Powers.

Apart from the severe financial strain imposed by the "eight-eight" programme, doubts have been cast upon the ability of Japanese industry to cope with so much naval work and complete it within the specified period. To do this would have necessitated an increase of approximately 50 per cent. in the present rate of output from the shipyards, engineering shops, armour and ordnance factories. When introducing the new programme to the Imperial Diet in July, 1920, the Minister of Marine said that the national building capacity was two capital ships a year. But if the whole of the fourteen new capital ships were to be in service by 1927 it is obvious that production would have had to be accelerated. Long before the Washington Conference met, certain organs of the Japanese Press said openly that the programme could not be completed to time-table without enlisting the aid of foreign builders, and it is no secret that inquiries have been made in this country by the Japanese authorities with a view to placing orders for warships. That no such contracts have actually been awarded is attributed to dissatisfaction with the terms quoted. Be that as it may, British industry has already been called upon to supply machinery, armour plate, and ordnance accessories for certain Japanese vessels now under construction. There is a natural reluctance in Japan to let more work go out of the country than is absolutely necessary, especially at a time like the present, when the shipbuilding and kindred industries have been badly hit by the slump in mercantile tonnage. Precise details of the shipbuilding resources now available in Japan are not easy to obtain. It is known, of course, that the Government yards at Kure and Yokosuka and the private establishments of Mitsubishi and Kawasaki can undertake "Dreadnought" construction, and have, in fact, built capital ships of the largest dimensions. Other private yards, however, may now be in a position to accept such work, thanks to the extensions that were made during the war period. Five such establishments were in process of developing their building facilities on a very large scale when the war came to an end, but it is not certain whether their plans have materialised. If they have it is probable that some, at least, of these yards could now build warships of any displacement. But the building of the hull is only part of the sum of labour represented by the completion of a great fighting ship, and while several of the yards in question may be competent to do this share of the work, it may be doubted whether they would be able to manufacture propelling machinery of such high power as that which is to be installed in the new ships—the battle-cruiser Amagi, for instance, is credited with engines of 170,000 shaft horse-power. Nor is it certain that the armour and ordnance plants, in spite of recent developments, could produce sufficient guns and armour plate to equip, say, four capital ships every year. A careful survey of Japanese resources in the light of the latest data obtainable leads the writer to estimate the maximum output of capital ships, complete in every detail, at three ships per annum. As regards smaller naval vessels, there are seven yards which can build and engine cruisers up to 8000 tons. The production of surface torpedo craft could undoubtedly be increased far beyond the present figure if it were deemed necessary to do so. Some noteworthy records in the rapid construction of these craft stand to the credit of Japanese builders, and a group of destroyers which had been completed in a few months went afterwards to the Mediterranean, where the vessels proved equal in every way to the arduous conditions of war service.

It is only during the past six years that Japanese naval opinion has become really impressed with the possibilities of submarine warfare. Since 1915, however, the submarine flotilla has been steadily reinforced, though the process was and still is attended with serious difficulties of a technical character. It was found that the European and American types from which the earlier boats were modelled were not well adapted to the peculiar conditions that govern submarine navigation in Far Eastern waters. Scantlings of abnormal strength are said to be essential in boats intended to operate in those latitudes. A purely Japanese design has been evolved, but reports as to its performance are somewhat conflicting. In particular, trouble is reported to have been experienced with the motors of native construction, and in recent years the tendency has been to rely very largely on foreign manufacturers for submarine engines. As is well known, Vickers, Limited, are now completing an order for several sets of submarine engines to Japanese account; and in August last it was announced that Messrs. Sulzer Bros., of Winterthur, had received a Japanese contract to the value of £1,250,000 for submarine Diesel engines in sets of 4000 brake horse-power each. From all accounts the programme of July, 1920, provided for an eventual establishment of eighty "first-line" submarines, ocean-going and coastal types, very few of which have been completed to date. It remains to be seen whether the residue of this programme which survives the reductions to be determined at the Washington Conference can be realised without enlisting foreign aid to a much larger extent than is the case at present.

Before leaving the subject of Japan's naval shipbuilding resources it will be well to correct a misapprehension which seems to be prevalent even in naval circles in this country, viz., that the industry in Japan is immune from the labour troubles which impose so serious a handicap on our own efforts in the same direction. Only a few weeks since one of the London newspapers printed an article by a British naval officer, who declared, *inter alia*, that "Japanese shipyard workers never strike." The accuracy of this statement may be judged by the fact that throughout last July and August the two greatest private shipbuilding yards in Japan, the Mitsubishi and the Kawasaki, were forced to remain idle in consequence of a strike involving no less than 40,000 workmen at Kobe alone, 90 per cent. of whom were engaged in shipbuilding trades. Further enlightenment on this subject is given by the following extract from a Japanese paper of September 22nd:—"Investigations published by the Furukawa Gomei Kaisha show that uncertainty of employment still continued to prevail during August, and disputes have multiplied since the second half of the year, owing to the spread of Labour doctrines, the workers claiming the rights of collective bargaining, the adoption of a factory committee system, &c. During August there were fewer troubles than in the previous month. The number of disputes totalled twenty-five, in which 39,991 labourers were involved. These figures show, as compared with July, a decrease of fourteen in the number of disputes and 6000 of labourers affected. Classifying by industry, the shipbuilding trade suffered most severely, embracing 63 per cent. of all the agitations." It will be seen, therefore, that the supposed Japanese advantage in respect of immunity from labour troubles in the shipbuilding world is quite illusory.

At the present moment there are four capital ships on the stocks in Japan. The Kawasaki Yard, Kobe, is building the battleship Kaga, and the Mitsubishi Yard, Nagasaki, the battleship Tosa. These are sister ships and both were due to take the water in October. Their launch, which has been delayed by the strikes mentioned above, is expected to take place this month—November. According to Press reports, their dimensions are:—Length, 700ft.; breadth, 100ft.; displacement, 40,600 tons. Their speed is to be 23 or 23½ knots, and they will mount eight or more 16in. guns. The other two ships being built are the battle-cruisers Amagi and Akagi, laid down respectively at the naval arsenals of Yokosuka and Kure in December, 1920, and January, 1921. Both were to have been launched early next year. Their unofficial details are:—Length over all, 880ft.; breadth, 103ft.; displacement, 43,500 tons; speed, 33 knots; main armament, eight 16in. guns. As soon as the slips now occupied by the Kaga and the Tosa became vacant the keels of two new battle-cruisers, the Atago and the Takao, were to have been laid thereon. These vessels, which may never be built, are generally described as sisters of the Amagi, but they were just as likely to have proved larger and more powerful in every way. The launch early in 1922 of the Amagi and Akagi would have left the slips at Yokosuka and Kure free for the laying down of the new battleships Owari and Kii, regarding which no details can be obtained.

We come now to the completed ships of the Japanese Navy, the various types of which are illustrated in our Supplement. The majority of these photographs, it may be mentioned, have not been previously published, and THE ENGINEER is indebted to the Imperial Navy Department, Tokyo, for permission to reproduce them. The Nagato is not only the largest fighting ship so far built for the Japanese Navy; she is actually the largest battleship in the world at the present time, and now that the American ships of the "Indiana" class are apparently to be scrapped

* The figures given were courteously furnished by the Imperial Navy Department, Tokyo.

she will probably retain that distinction for a good many years to come. Her sister ship, the Mutsu, was completed this month and is now finishing off her trials. The Nagato was begun at Kure Dockyard in August, 1917, and did not reach the launching stage till November, 1919. She was formally commissioned in December, 1920, as flagship of the First Fleet, and now flies the flag of Admiral Tochinai. In general features she conforms to what has become the standard type of capital ship, characterised by a main armament of eight heavy guns mounted on the centre line—the type which originated with the British "Queen Elizabeth" and "Royal Sovereign" classes, and is now represented in the American Navy by the Maryland. The dimensions of the Nagato are as follows:—Length between perpendiculars, 660ft. 7in.; breadth, 95ft.; mean draught, 30ft.; normal displacement, 33,800 tons. She is fitted with turbines with reduction gear, developing 48,000 shaft horse-power. The designed speed of 23½ knots was attained with ease on the steam trials. Very heavy armour and special underwater protection has been worked into this ship, but details as to the thickness of plating, &c., are carefully guarded. Such views and drawings as have appeared do not indicate the presence of a bulge. Eight 16in. 45-calibre guns constitute the main armament, the disposition of which is clearly shown in our illustration. The 16in. gun discharges a projectile of 2190 lb. with a muzzle velocity of 2800 foot-seconds, and the nominal figure of penetration at a range of 12,000 yards is 12in. of hardened steel. The first Japanese gun of this calibre was built at the Muroran steel works, the breech mechanism being made at Kure arsenal. It is said to have proved a most successful weapon. The adoption of 16in. guns by the Japanese Navy was due to the initiative of Admiral Baron Kato, the present Minister of Marine—now representing his country at the Washington Conference—who is strongly in favour of big calibres. It is interesting to note that a full broadside from the main battery of the Nagato would weigh 17,520 lb., the corresponding figures for the Maryland being 16,800 lb. and for the Queen Elizabeth or the Hood 15,360 lb. The Nagato thus fires the heaviest broadside of any warship completed up to the present date. She carries in addition twenty 5.5in. 82-pounder quick-firing guns, mounted in casemates on the upper and forecastle decks; three or four anti-aircraft guns, and eight torpedo tubes, some of the latter being, it is said, placed above the water line. Externally, the most arresting feature of this magnificent battleship is her foremast, which consists of a central trunk of large diameter supported by six struts. An electric lift working within the main trunk affords rapid access to the fire control station at the mast-head. This heptapodal structure was built as the result of experiments which were made to ascertain the form of mast that would give the greatest rigidity and also offer the strongest resistance to shell attack.

The battleship Ise and her sister ship, Huiga, belong to the 1914 programme, both being laid down in May of the following year. They are comparable in fighting power with their American contemporaries of the "New Mexico" class. The leading dimensions are:—Length between perpendiculars, 640ft.; breadth, 94ft.; extreme draught, 28ft. 4in.; normal displacement, 31,260 tons. Turbine machinery of 45,000 shaft horse-power is installed, the designed speed being 23 knots. The water line, the main artillery positions, and other vital parts are protected by armour 12in. thick, but the armour decks appear to be less substantial than is now deemed desirable in modern capital ships. As these vessels were not begun till nearly ten months after the outbreak of war it is to be assumed that special attention was paid to their defence against under-water attack. The main armament comprises twelve 14in. 45-calibre guns paired in turrets on the centre line, two being placed forward, two amidships, and two at the stern. Twenty 5.5in. quick-firing guns are mounted, mostly in upper-deck casemates, and there are four anti-aircraft guns and six submerged torpedo tubes. These vessels are slightly improved versions of the Fuso and Yamashiro, which were laid down respectively in 1912 and 1913, and the dimensions are very similar, except that the Fuso and her sister are 10ft. shorter and displace only 30,600 tons. Moreover, the speed is only 22 or 22.5 knots. The main armament is the same, but, as will be noticed in the illustration, the amidship turrets are disposed on a different system. The armour protection is practically identical with that of the Ise.

Although she belongs to a type which is already obsolescent, the battleship Settsu is of interest as representing the first purely Japanese conception of an all-big-gun capital ship. Her keel was laidat Kure Dockyard in April, 1909, and she came into service some three years later. She is 533ft. in length over all, 84ft. 2in. in breadth, and displaces 21,420 tons. Curtis turbines of 25,000 shaft horse-power give her a speed of 20.5 knots. Good protection is afforded to the vital parts by 11in. and 12in. armour and several strong decks. The main armament is twelve 12in. guns, those in the forward and after turrets being 50 calibres long, while the remaining eight are 45 calibres in length. The disposition of the turrets is such that only eight guns will bear on either beam, and thus the full benefit of the powerful armament is not obtained. Originally there was a sister ship, the Kawachi, but she was completely destroyed in July, 1918, by an internal explosion.

In proportion to its strength in armoured ships the Japanese Navy is well supplied with light cruisers. Two of those authorised under the current programme are to be ships of more than 7000 tons. Other light cruisers being built or completed are the Yura, Isudzu, Nagara, Natori, and Kiso, while four ships of the same general type—Kuma, Tama, Oh-i, and Kitakami—have been completed during the past twelve months. All the vessels named are practically uniform in dimensions, displacing from 5500 to 5780 tons, with a speed of 33 to 33.5 knots, and an armament of seven 5.5in. guns. It is believed that they burn oil fuel only, a system which has not yet been extended to the heavier vessels of the Japanese Navy, owing to the difficulty of securing a supply of this fuel adequate for all emergencies. The Tatsuta and Tenryu, completed during 1919, have many features in common with the British "Arethusa" class, to which, perhaps, they owed their design. They are 400ft. in length, with a beam of 40ft. 9in., and displace 3500 tons. Their speed is 31 knots, and they were the first large Japanese vessels of war to burn oil only. A light armament of four 5.5in. guns is carried, together with six torpedo tubes on triple-deck carriages. The Hirado and her sisters, Yahagi and Chikuma, were laid down in 1910. In their case a not unsuccessful attempt was made to combine good speed, an extensive radius of action, and a powerful armament on a displacement of 4950 tons. The principal details are as follows:—Length overall, 475ft.; breadth, 46ft. 6in.; machinery, turbines of 22,500 shaft horse-power for a maximum speed of 26 knots—exceeded on trial; armament, eight 6in. 50-calibre guns and three torpedo tubes. All three ships performed splendid service in the Great War, steaming many thousands of miles without experiencing any engine-room troubles.

Japanese destroyers are of two types—first-class boats, *i.e.*, above 1000 tons, and second-class boats, *i.e.*, below 1000 tons. It has been customary for some time past to provide for both types in every annual programme. The latest first-class boats approximate in size and armament to our flotilla leaders. They displace from 1300 to 1400 tons, have a designed speed of 34 knots, and mount three or four 4.7in. guns, with six 21in. torpedo tubes. To this group belong the seven vessels of the "Minekaze" class, and also the Tanikaze and Kawakaze. The Amatsukaze and her three sisters, launched in 1916, were the first of the really modern type of first-class destroyers. They displace 1227 tons, and have touched 35 knots in service. The armament consists of four 4.7in. guns and six 18in. torpedo tubes. The "Momo" class—ten boats in all—may be taken as typical of the new second-class type: Displacement, 835 tons; speed, 31.5 knots; armament, three 4.7in. guns and six torpedo tubes.

Reliable details of modern Japanese submarines are difficult to obtain, for in this respect the naval authorities follow the example of other Powers in observing strict reticence. There is, however, reason to believe that the underwater vessels now constructing in Japan will be at least equal in size, sea endurance, and armament to the largest submarines building abroad. A special interest attaches to our illustration of submarine No. 19, for this boat is—or was until quite recently—the largest submarine in the Japanese Navy, and was also the first ocean-going boat of purely native design. She displaces 890 tons in surface trim and 1200 tons when submerged. The surface speed is 16 knots. Five torpedo tubes are mounted, two of which are in the bows, one in the stern, and two above water on each side of the superstructure. The position of these deck tubes is well shown in the illustration. The nominal sea endurance of No. 19 is 6500 sea miles, but the actual cruising radius is probably well above that figure. No. 26 is one of the latest boats, having been completed for service early in the present year. Her displacement when submerged is about 1000 tons, and her speed on the surface 16.5 to 17 knots. With two-thirds of her maximum fuel supply on board she can travel a distance of 7500 sea miles. The torpedo armament is limited to four tubes, but a quick-firing gun is mounted on the deck—3in. in some boats of this series, 4.7in. in others. In the later submarines now in hand an attempt has been made to increase the radius of action very considerably, for it is recognised that cruising endurance is of the utmost importance in submarines designed for operations in the Pacific. In future, it is said, the Japanese naval authorities will concentrate on two distinct types: (1) submersible cruisers of good speed, mounting a powerful gun and torpedo armament, and in some cases equipped for mine-laying; and (2) smaller ocean-going vessels, not exceeding 1000 tons, of 17 to 18 knots speed, and carrying a lighter armament. According to one account, "the purely coastal type will not be perpetuated, for experience has shown that it is false economy to construct diminutive submarines when the addition of a couple of hundred tons in displacement endows a boat with good sea-going qualities and a far higher degree of all-round fighting value." The big *versus* little ship controversy has seemingly spread to Japan, for the naval authorities have been criticised by a section of the Press for continuing to build heavy armoured ships instead of devoting the equivalent in money and labour to the construction of a multitude of submarines. Nevertheless, the official policy, as explained by the Minister of Marine nearly two years ago, remains unaltered. Speaking in the Imperial Diet, Admiral Kato said: "The more we study the lessons of the war, the stronger does our conviction grow that the last word in naval warfare rests with the big ship and the big gun."

Einstein and the Theory of Relativity.

By Major H. J. JONES, O.B.E., R.A.O.C., A.M.I. Mech. E., A.R.C.S. &c.

No. II.*

THE DISTANCE BETWEEN TWO POINTS.—THE TIME BETWEEN TWO EVENTS.

THE considerations given in the previous article having brought us into direct contact with Einstein's work, it is expedient, in order to avoid misconceptions, to reiterate again that relativity dynamics deals solely with the measurement of bodies or events that can be localised in terms of distance and time, and not with our awareness or conceptions of these things. Unless we keep this measuremental aspect of the subject perpetually before our mind's eye we shall become involved in the utmost mental confusion.

What do we mean, then, by the phrase "the distance between two points," and, by implication, "the position of a point?" And when we speak of "the time interval between the occurrence of two events," what exactly is the nature of the information we wish to convey? As regards "distance," whatever our conceptions may be, it appears that the following is the description of what we assume in practice actually represents the distance between two points. We select a rigid standard or gauge of magnitude, which may be indicated by marks on a metal rod or by the distance between its plane ends; and, by a process of repetition, we determine experimentally the number of times this standard or gauge of magnitude is contained in the Euclidean straight line joining the two points. If we wish to give a rational and consistent meaning to the number so obtained, we make the following assumptions:—

(1) That the length of our gauge of magnitude is invariable with time and with its position relatively to the points.

(2) That if the two points, although in motion, are relatively at rest, the effect of the motion on the gauge is constant.

(3) That if the two points are not relatively at rest, we can determine, by measurement, their instantaneous positions, and state that, at a definite instant, the distance between the two points was so many times the gauge of magnitude.

(4) That we can manipulate the distance so measured in accordance with ordinary trigonometrical and Euclidean formulæ.

Reflection on the above procedure and the assumptions made in the method of measurement shows that we express our measurement as a mere number that has no significance apart from our arbitrarily chosen gauge of magnitude; and, ignoring irrelevancies such as heat and mechanical strains, we assume our rigid standard of length remains invariable with time and motion. In addition, we assume we can determine the instantaneous position of the two points irrespectively of their motion relatively to the point of observation. Einstein was the first to show that these assumptions, obvious as they appear, involve much that is impossible and much that is untrue.

In everyday life, when the distances are short, we actually use with our gauges and rules and tapes the process of repetition described above, and in these cases the points are almost invariably relatively at rest, and the gauge is made to have, by the conditions of its use, the actual common velocity of the two points. But when the distances are great and when we are dealing with astronomical phenomena, or measuring distances between unattainable points, we are forced to use another gauge of magnitude, and the only one available at present is the distance travelled by a wave of light in one second. In other words, a physical straight line is assumed to be the path of a ray of light, and a physical distance the time taken by a wave of light to pass from one point to another along the physical straight line. It will be remembered that we have experimental evidence already as to the suitability of a ray of light for our gauge of magnitude; for the measured velocity of a ray of light has been shown to be unaffected by the earth's orbital motion through the æther—the velocity is the same parallel with the earth's motion, or at right angles to it, at any time of the year. And, in addition, Ritter has found confirmatory evidence for the constancy of the velocity of light in his stellar observations. For the present, therefore, we shall accept a wave of light as a convenient gauge of magnitude expressible as distance or as time.

As regards "the position of a point," its measured position obviously implies measurement from some other point. For many purposes it will be neither sufficient nor convenient to speak of its mere distance from another point. We shall require to get some idea of direction—that is, its position relative to

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several different points. To do so it is customary to select three planes, mutually at right angles, and passing through a selected origin, or point of reference, and express the distance of any other point in terms of the co-ordinate perpendicular distances (x, y, z) of the point from these three planes. The position of all points being expressed in this way, we can readily connect their co-ordinates and obtain the spatial relations of any one point to all other points.

It is clear that if we wish to establish perfectly general laws of Nature—that is to say, express the intrinsic character of natural phenomena uncoloured or distorted by the unique circumstances of a particular observer—we shall have to consider not only those measurements taken under the circumstances of terrestrial observation, but also those it is possible to imagine taken by any other observer having any other sort of motion; and in order to interpret his results we shall assume that he will use the velocity of light as his gauge of magnitude, and that whatever be the character of his units of length and time, he will experience also the constancy of the velocity of light irrespectively of the motion of his point of observation.

Imagine, then, say, three points: A, that of observation, and B and C, those between which the distance is to be measured. Let these points have any sort of motion relatively to each other, and consider what is involved in the measurement of the distance B C from the point A by any conceivable optical device. Obviously, since a light signal takes a definite time to travel from any one point to any other, and since during this time the relative positions of A, B, and C will have changed owing to their motion, it is clear that we shall not be able to get a measurement of B C without including terms involving the relative velocities of the three points. In other words, the distance B C is not a quantity that we can measure and express as a mere number and a gauge of magnitude; it must always include and express the spatial relations of the motions of the three points. If we had at our disposal an instantaneous method of signalling, in place of the finite velocity of light, this difficulty would not arise, as, during a single instant the relative positions of the three points would not be altered; we should take an instantaneous snapshot of them, as it were.

The above consideration indicates at once the defect of Newtonian dynamics. Newton's laws of motion express certain relations between the distances and time involved in the motion of bodies, and their truth or validity must stand the test of verification by actual measurement. But the laws imply an absolute measuremental knowledge of distance and time which, as far as is known, cannot be ascertained by any means at our disposal. Thus when we state the law of gravitation in the form "Bodies attract each other with a force which is directly proportional to the product of their masses, and inversely proportional to the square of the distance between them" we intend "the distance" between them to mean the instantaneous distance. But, as we have seen, the instantaneous distance between bodies in relative motion cannot be measured without an instantaneous system of signalling, and, as far as we know, such a system does not exist. In addition, the law implies that bodies possess a property called "mass," which is constant, or at any rate independent of their motion, whereas modern electro-dynamical knowledge points conclusively to the fact that the mass of a body is by no means constant and has a most intimate connection with its velocity. Consequently Newton's Law of Gravitation is made inadequate to the point of being meaningless. Whatever our conceptions of distance, and hence of space may be, in actual practice we can only measure it as a relation involving motion. When we learn, as we shall later, that force and mass and all the other fundamental concepts of classical dynamics are also quantities purely relative to motion, it will be seen that Newton's laws are badly in need of re-examination if we are to look upon them as expressing the intrinsic qualities of natural phenomena.

In Newtonian dynamics distance and time were looked upon as self-subsistent, non-mental realities. Any point of space was said to be adequately described or located by its co-ordinate distances from specified planes of reference. Time, however, was considered to possess a totally different status to distance. Thus the path of a moving body was spoken of as something physically real, and existing independently of all external bodies and observers, and without any reference to time whatever. Similarly, the time of an event was considered without any reference to spatial boundaries. Time was supposed to be a reality that flowed smoothly on, like a river as it were, and the time of events happening on the banks was conceived to be measured by the quantity of water passing. But the water flowed on irrespective of any events, and intrinsically had no connection with them whatever. In other words "conceptual time" and "measured time" were considered to be identical.

It is the great merit of Einstein that in going back to a re-examination of the old dynamical assumptions he has been able to show how inexact and crude our conceptions of measured distance and measured time have been. In relativity physics Hermann Minkowski and Einstein have laid great stress on the inevitable interdependence of measured distance and measured time. Thus Minkowski, in his famous Cologne lecture, "Raum und Zeit" (1908), said:—"From henceforth space in itself and time in itself sink to mere shadows, and only a kind of union of the two preserves an independent existence." And Haldane, in his "Reign of Relativity" (p. 46), writes:—"Space and time are really abstractions from a reality which includes them both in mutual implication." But these statements may be most misleading unless we realise that it is the *measured* relations, and not the intuitional relations between space and time with which we are dealing. Eddington, in "Space, Time, and Gravitation" (p. 16), is quite clear on the matter:—"But the relativist, in defining space as measured space, clearly recognises that all measurement involves the use of material apparatus; the resulting geometry is specifically a study of the extensional relations of matter . . . since natural geometry is the study of extensional relations of natural objects, and since it is found that their space order cannot be discussed without reference to their time order as well, it has become necessary to extend our geometry to four dimensions in order to include time." And Haldane (p. 87) writes:—"We measure time by treating it as a relation of space, and it is only in terms of space that we can measure it."

The above statements, dogmatic as they are, must not blind us to the fact that they merely express the fact that since we are forced to use the velocity of light as our gauge of magnitude, all our measurements must include within them relations of distance and time. We cannot separate distance and time in absolute independence, because our very gauge of magnitude involves them both. But this circumstance is merely accidental. The relativist claims to have deprived measured space and time of the absolute self-subsistent character which Newton assumed they possessed, and put them in functional relation one to the other. Yet, as we have seen, this functional relation arises merely because, as a matter of necessity or convenience, we use the velocity of light as our gauge of magnitude. It is true we usually measure time by spatialising it—that is to say, we measure equal intervals of time by observing the coincidences of a body moving at uniform velocity over points equally distant from each other, such as the hands of a clock moving over the dial spaces. But this procedure is by no means inevitable. Otherwise we should describe as inevitable the description of voltage as the rate at which a conductor cuts lines of force in a magnetic field, and ignore electro-chemical or electro-thermal derivations of electric pressure. It is agreed that time is most conveniently measured by reference to the changes in position of moving bodies; but it may be measured also by reference to changes of state, which need not involve considerations of movement at all. A photographic exposure meter, for instance, measures time by colour changes, and even with a clock we can measure time by the absolute process of counting the ticks. That the process is inconvenient is beside the point. It is conceivable that a measure of time could be obtained by counting the periodic fluctuations in the brightness of a variable star, or by counting the emission of quanta in radiation phenomena. In all these cases movement of gross or of molecular matter can be inferred; but the point is that a definite measure of time is obtained without any reference whatever to the coincidences of one moving body with another, or to a rigid gauge of magnitude. In other words, spatial considerations do not enter into the measure of time obtained by counting changes in state or condition. Measured intervals of time, therefore, have in themselves a physical reality much more substantial than Minkowski seems to allow. And when we describe the dynamical state of a particle by adjacent values of its $(x, y, z) \cdot t$, it must be understood that the first three, although merely arbitrary components of a real distance, have much more intimate relations to each other than either have with the fourth. Nevertheless, it is true that when measuring by means of optical apparatus we cannot dissociate distance from time relations, and the complete description of the motion of a point must include the order in which events occur in time as well as their order in space. In other words, a particle must be considered to have four descriptive co-ordinates $(x, y, z) : t$, the magnitude of the interdependence of which is revealed only when we change from one set of planes of reference to another set.

It is clear from the above argument that in all physical phenomena we must distinguish between "local distance" and "local time," and "external distance" and "external time." In other words, we must distinguish between the distance and time measured by an observer moving with the system of reference, and at rest relatively to it, and all other external observers who have motion relatively to the system of reference. Thus, in the case of electro-dynamics and radio-activity we are dealing with velocities comparable with that of light, and we have to consider the nature of the observations made by an observer moving with these velocities. We have, in fact, to seek for general laws of Nature which will be applicable to his unique circumstances as well as to our own, or to any observer whose velocity is not comparable with that of light.

We may take it as axiomatic that for the purposes of description there are no restrictions on our choice of origin or planes of reference. The origin may be anywhere and the direction of the planes made to suit our convenience. Assume, for simplicity, that the origin is taken to be coincident with the point of observation, and that for the moment we restrict our investigations to uniform rectilinear motion. It is a fundamental condition that the intrinsic qualities of the phenomena under observation have nothing whatever to do with our choice of origin and planes of reference; that however we describe natural events, we cannot thereby affect their integrity. The choice of certain origins may result in a simplified description, in fact considerations of mathematical simplicity will usually determine our choice; but the phenomena in themselves remain unaffected. Thus great simplification resulted in astronomy when we abandoned the Ptolemician system in the fifteenth century, with its "eccentrics" and "epicyclics," for the system of Copernicus, which, by a mere transference of the origin from the earth to the sun gave circles, and then more accurately, ellipses, as the geometrical description of planetary motion. But the Law of Gravitation lay hidden in the one system just as much as in the other.

The question now arises: "Having obtained the co-ordinates (x, y, z) t and the mode of their variation relatively to one origin O and set of planes of reference, by what process of transformation can we obtain the co-ordinates (x^1, y^1, z^1) t^1 of the same particle relatively to another origin O^1 and parallel set of planes, the second origin having a uniform rectilinear velocity V relatively to the first?" The solution is by no means difficult and has been given in various forms by Lorentz, Laue and Einstein. It is usually referred to as the Lorentz transformation, although used apparently by Voigt so long ago as 1887.

For simplicity take the direction of the axis of x as parallel with the direction of motion V; then if (x, y, z) t be the co-ordinates referred to the origin O and (x^1, y^1, z^1) t^1 be the co-ordinates referred to the origin O^1, the transformation reduces to—

$$x^1 = \frac{x - Vt}{\sqrt{1 - \frac{V^2}{c^2}}} \qquad y^1 = y$$

$$t^1 = \frac{t - \frac{V}{c^2}x}{\sqrt{1 - \frac{V^2}{c^2}}} \qquad z^1 = z$$

This transformation is reciprocal, since if O^1 has a velocity $+ V$ relatively to O, O has a velocity $- V$ relatively to O^1; hence—

$$x = \frac{x^1 + V t^1}{\sqrt{1 - \frac{V^2}{c^2}}} \qquad y = y^1$$

$$t = \frac{t^1 + \frac{V}{c^2}x^1}{\sqrt{1 - \frac{V^2}{c^2}}} \qquad z = z^1$$

In view of the fact that this transformation is enormously important in the development of relativity dynamics, it is necessary to examine carefully the assumptions on which it is based, as well as some of its immediate implications. The assumptions are three in number and are called by Einstein: (1) The Restricted Principle of Relativity, (2) The Constancy of the Velocity of Light, (3) The Idea of Simultaneity. They are defined as follows:—

(1) *The Restricted Principle of Relativity.*—The laws according to which the states of physical systems are changing have the same mathematical expression whether they are referred to an origin O and set of axes coincident with the point of observation, or to any other origin O^1 moving with uniform rectilinear motion relatively to O.

(2) Every light disturbance is propagated in vacuo, relatively to the origin O, with a constant finite velocity C, no matter whether it is emitted from a body stationary or moving relatively to O.

(3) Events that are simultaneous at one and the same place for an observer at O are also simultaneous for an observer at O^1.

It is important to note that the restricted principle of relativity, as defined above, is not a philosophic principle, but a generalisation based on the concordance between deductions derived from it and the results of experience. The same applies to the constancy of the velocity of light; all experiments, whether terrestrial or celestial, have so far given null results as to the effect of motion of the source on the velocity of light. The idea of simultaneity appears to be perfectly obvious, but it is true only because we limit the simultaneity to one and the same place. It will appear later that events which occur at places separated from each other, although simultaneous for an observer at O, are not simultaneous generally for an observer at O^1.

The first feature to note about the Lorentz transformation is that, if instead of light as our gauge of magnitude, we had at our disposal some infinite speed—that is to say, if C were infinite—then the transformation would be reduced to—

$$x^1 = x - V t, \quad y^1 = y, \quad z^1 = z, \quad \text{and } t^1 = t.$$

In other words, the time co-ordinate t would be the same for all systems and independent of all spatial relations; in fact, we should have the transformation of Newtonian dynamics. The exact position of the

latter is now laid bare. Newton assumed that measured time had an absolute character the same for all co-ordinate planes of reference, whereas the Lorentz transformation shows that measured time must involve considerations of relative motion, and gives the mathematical interdependence of distance and time on which Minkowski laid too much stress, perhaps. Just as we consider a "force" as a reality, but its components along any two directions at right angles as convenient mathematical fictions, so Minkowski looked upon the (x, y, z) t co-ordinates of a moving point as the convenient mathematical fictions of a reality in the physical world. This view, however, appears to be in the nature of a mathematical exaggeration. The conception of natural phenomena presented by Whitehead seems to be much more balanced and rational. He adheres firmly to the hypothesis that although the quantitative relations of events will vary according to the time-space system selected for their expression, yet time and space do signify sovereign facts of Nature, although what one observer means by them is different from what another observer means.

Developments in Power Station Design.

No. XVII.*

In the design of coal and ash-handling plant a fair amount of ingenuity has been displayed, but many of the contrivances in use are too well known to need description. The Bennis U link steel chain conveyor, the gravity bucket conveyor, the band conveyor and various forms of push plate and scraper conveyors are perfectly familiar to all power station engineers. Ed. Bennis and Co. are, however, advocating a coal storage system which, in view of the saving it is claimed to offer, is worthy of consideration. For many years it has been the general practice in power stations to store coal in overhead bunkers, but the system demands an expensive conveying and elevating plant and generally a specially designed boiler-house. To reduce the cost of the overhead structure and to secure other advantages which will be dealt with later, Ed. Bennis and Co., Limited, now sometimes adopt the plan of building the bunkers on the ground level and along the front of the boilers, the coal from these bunkers being transferred directly to the mechanical stokers by a series of elevators, as shown in Figs. 85 and 86, each boiler having an elevator of its own.

The size and shape of the bunker depends upon local requirements, but in any case large ground bunkers are relatively inexpensive, as the amount of storage is only limited by the height of the walls of the building and the floor space available. The bunker practically forms a separate storage chamber in front of the boiler, and the coal is not visible from the firing floor. Various methods are adopted for delivering the coal into the storage bunkers. In many places it is possible to run the railway trucks over the tops of the coal stores to dump the coal direct from the trucks into the bunkers. This method is usually adopted where the rail level is higher than the firing floor level. Where, however, the rails are level with the firing floor the trucks are emptied into a receiving hopper built beneath the railway track at one end of the bunkers, and the coal is tipped into the bunkers by a conveyor and elevator. The advantages claimed for the scheme are:—(1) The cost of the bunkers is considerably reduced; (2) as the coal is stored on the ground level it can easily be inspected; (3) the usual expense of raising the coal to the bunkers is obviated; (4) within reasonable limits the bunkers can be extended indefinitely; (5) the amount of storage is only limited by the floor space available; (6) no special structural design is required for the boiler-house; (7) each boiler forms, with its elevator, a separate unit; and (8) in the case of emergency coal can be trimmed direct from railway trucks.

Considerable attention has been paid by Ed. Bennis, Limited, to the question of removing ashes from boiler-houses. At one time labour was so cheap that it was more economical to employ a few unskilled labourers than to spend money on ash removal plants, especially as the wear and tear on such plants is apt, owing to the abrasive and corrosive nature of the material dealt with, to result in high maintenance charges. To reduce the cost of upkeep the firm supplies a conveyor which consists of a series of cast trays fixed to an endless chain in such a manner that the trays form a continuous trough which runs on rollers along a track. This conveyor is suitable for conveying either red-hot ashes, wet ashes or ashes containing large pieces of clinker, and the conveyor is arranged so that it will carry ashes horizontally up and down an inclined plane. As the trays are constructed so that they possess great wear and heat-resisting properties; the wear and tear is said to be almost negligible. Another method of removing ashes is, of course, by means of steam jets or pneumatic suction. The pneumatic system is intended mainly for large plant, producing ashes at the rate of 3 tons per hour and upwards, and where the ashes must be removed as quickly as possible. For small plants with, say, two or three boilers, the steam jet suction system is most suitable. When a pneumatic plant is installed, the red-hot ashes, as they are withdrawn from the boilers, are passed directly into a pipe and are carried by suction to a receiver tank, where they are stored until it is convenient to place them in railway trucks or other vehicles. If the ashes are discharged from the boilers in the form of large clinkers they are passed through a breaker. One end of the ash pipe leads to the closed receiver which, during the time the plant is at work, is under suction and is cooled by water sprays at the top.

After the ashes have been deposited the foul air is carried to the exhauster, but a considerable amount

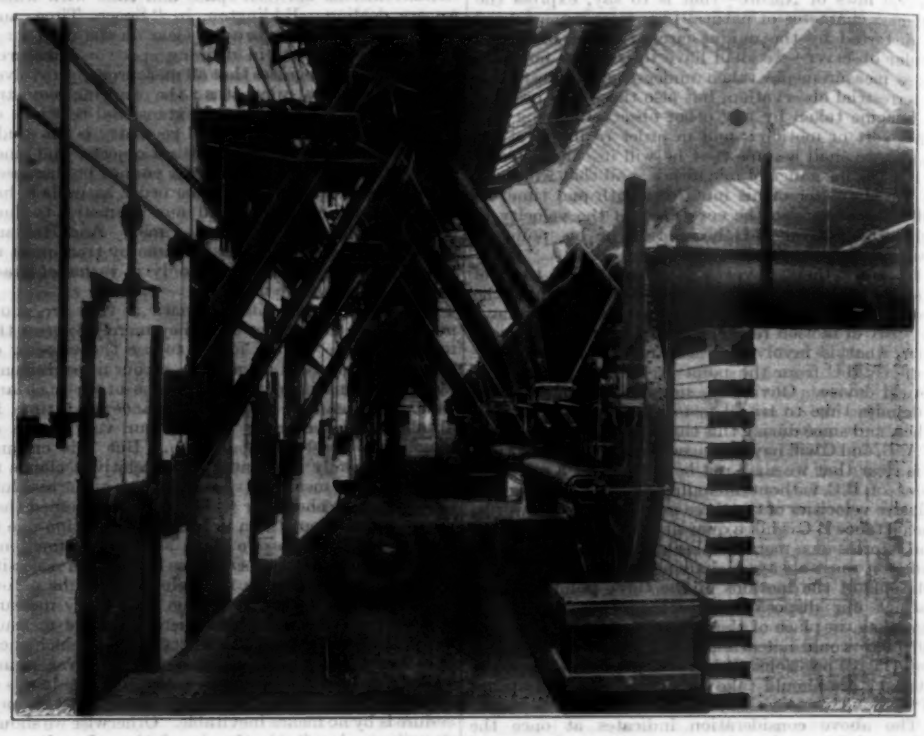


FIG. 86—BOILER HOUSE WITH GROUND LEVEL BUNKERS

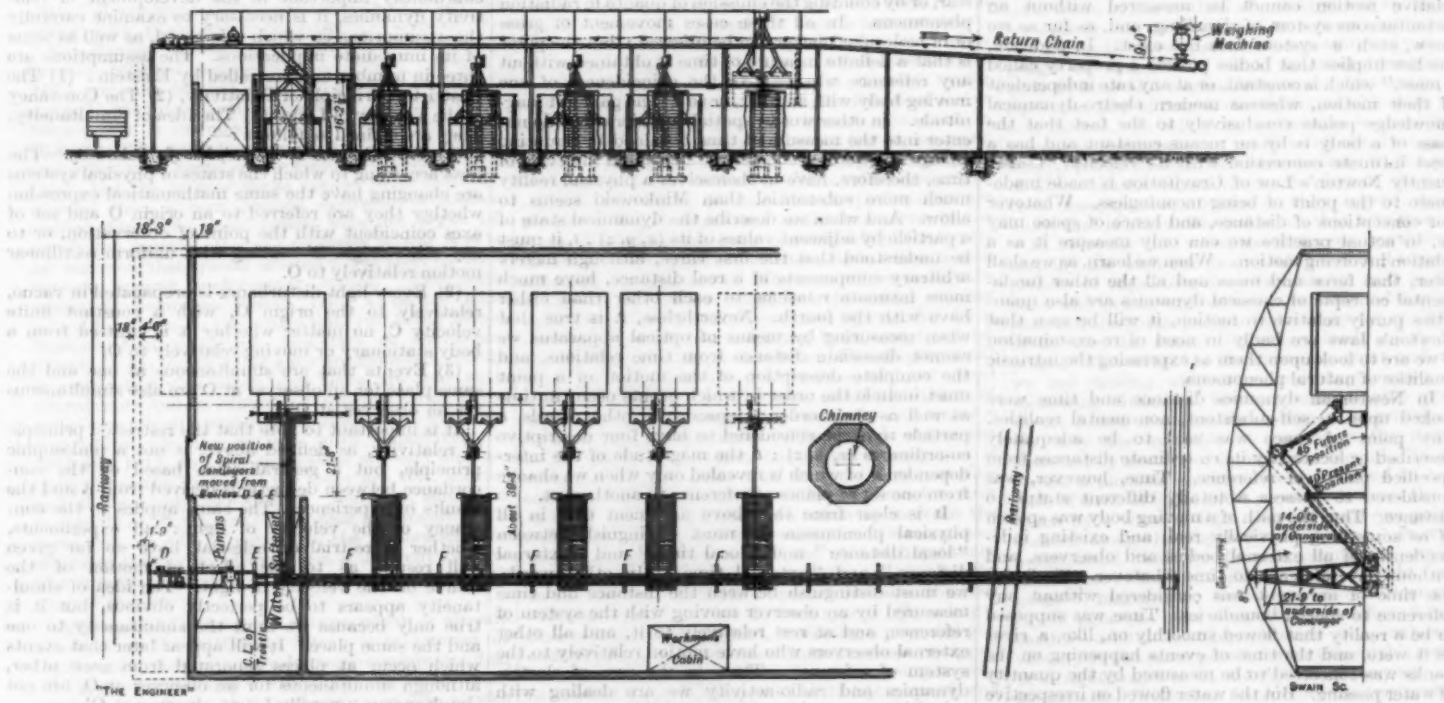


FIG. 85—ARRANGEMENT OF BOILER HOUSE WITH GROUND LEVEL BUNKERS

*No. XVI. appeared November 18th.

of dust and fine particles of ash are held in suspension in the air, and if this dust were passed into the exhauster the internal parts would, on account of the abrasive nature of the dust, be subject to excessive wear and tear. Before the air reaches the exhauster, therefore, it passes through a filter which extracts the dust and deposits it in a sludge tank from which it is periodically removed. The cleaned air then passes on to the exhauster and thence through a silencer into the atmosphere. With this type of plant the ashes are removed with a minimum amount of manual labour. In fact, the plant can be arranged so that the ashes are not handled by men at all. The ashes can be passed direct into the ash pipe, which carries them to the storage tank and from which they are delivered into carts or trucks. The suction is obtained by a Roots' exhauster driven by an electric motor or engine. The receiver or tank can either be made of mild steel plate or concrete. The ash pipes are usually made of cast iron, and as most of the wear takes place at the bottom of the pipes they are arranged so that they can be periodically rotated through a portion of a circle in order to prolong their life. The greatest wear naturally takes place at bends where the direction of the pipe changes, and in view of this the bends are constructed so that the parts that are liable to wear can easily be replaced. Suction ash plants occupy very little room in the boiler-house, and they eliminate ash trucks. There are no exposed ashes in any part of the boiler-house. With the exception of the exhauster, the plant is devoid of moving parts, and it is said that, provided the plant is periodically inspected and cleaned, nothing can get out of order. It is a very convenient type of plant for moving ashes over fairly long distances, and it can be worked with unskilled labour.

A large suction ash plant working on the above principle has recently been installed by Ed. Bennis, Limited, in the Blackburn Meadows generating station belonging to the Sheffield electricity supply department. The ash is passed through an electrically driven ash crusher, which runs on rails in the boiler-house basement, and it is moved by hand from boiler to boiler as required. As the ashes fall over the back of the chain grates they drop into ash hoppers—see Fig. 87—from which they are periodically removed by opening a valve at the bottom. As soon as the valve is opened the ashes fall into the ash breaker—shown in Fig. 88—and then into the main ash pipe. They are then conveyed by suction through the pipe into the air receiver from which they are eventually dropped into a concrete storage tank. Soot and dust are collected in the soot chambers at the bottom of the boilers, and are passed through valves and connections into the main ash pipe, which carry them into the ash receiver, where they are stored and removed together with the ashes. Each row of boilers has its own suction ash main, receiver, cleaner and exhauster, but the two ash plants are coupled together so that the ashes from either set of boilers can be delivered into either of the ash receivers, and each of the ash-handling plants can, if necessary, handle the ashes from the whole of the boilers.

In the event of an explosive mixture accumulating in the system, as the result of unburnt gases mixing with the fumes from red-hot clinker and steam, there are means for relieving pressure resulting from the explosion, and the plant cannot, it is said, be damaged. The foul air is passed through a filter or cleaner which extracts the dust and deposits it into a sludge tank beneath the cleaner, from which it can be periodically removed. As the air is cleaned before it passes through the exhauster, wear on the internal parts is avoided. The receiver consists of an air-tight circular mild steel vessel with a conical top and bottom, and is lined with brickwork. As the incoming ashes fall upon those already inside the receiver, wear on the sides is avoided. The outlet valve at the bottom of the receiver maintains, it is stated, an air-tight joint whilst it is closed; but means are provided for draining off any surplus water from the inside of the receiver whilst the plant is under suction. There are two ash breakers, one on each side of the boiler-house. On the main air pipes provision is made for the automatic admission of free air to the exhauster in the event of any sudden stoppage in the ash pipes, and this prevents damage to the motor through overload. Arrangements have also been made for the automatic control of the flow of water passing through the air cleansing sprays so that the amount of water used is reduced to a minimum.

For small plants composed of, say, four or five boilers, the first cost of the pneumatic suction equipment is prohibitive, and to overcome this the steam suction ash conveyer has been devised. The pressure for removing the ashes is obtained by a series of steam jets placed at different points in the ash pipe, and the ashes are shifted partly by suction and partly by pressure. With this class of plant it is unnecessary to have a closed ash tank, and the ashes can be delivered either into an open tank or on to the ground. The ash pipes, bends, inlet, &c., are made on the same general lines as those used on the pneumatic suction plant. The pipes are fitted with bends, tees and corner pieces which have removable chilled metal wearing parts. For taking the ashes and clinkers away a pipe line is laid in the boiler-house, generally under the floor plates. The ash intakes are in the floor in front of the boilers, and the ash is raked into the pipe through holes which can be closed by means of valves. Economisers and flues can be cleaned by similar means. Six inch or 8in. pipes are used for the clinker and ashes, and 4in. pipes for the branches which are used for cleaning the economiser and flues. With the steam valves opened the ashes are raked into the intake, and they are conveyed by means of the suction created to the desired point where they can be discharged into an overhead hopper, and from this hopper the ashes can be removed as desired. The ashes can be elevated a considerable height—say, 200ft. to 300ft.—from the boiler-house.

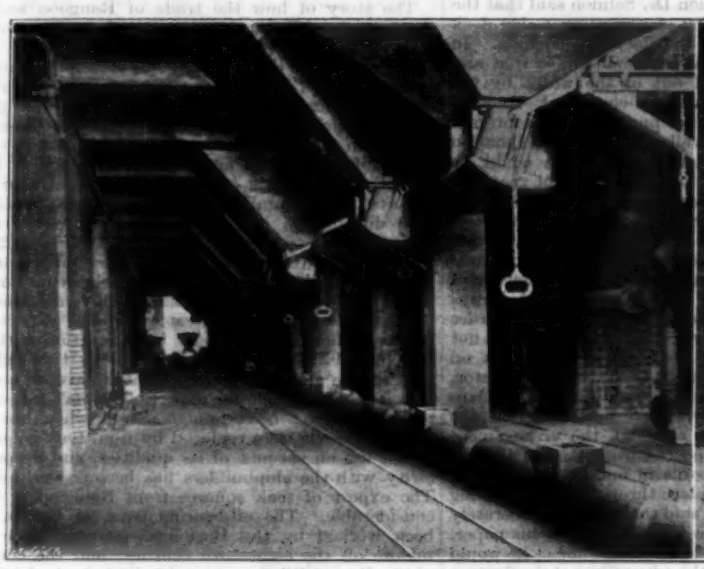


FIG. 87—ASH DISCHARGE HOPPERS AND SUCTION REMOVAL PIPE

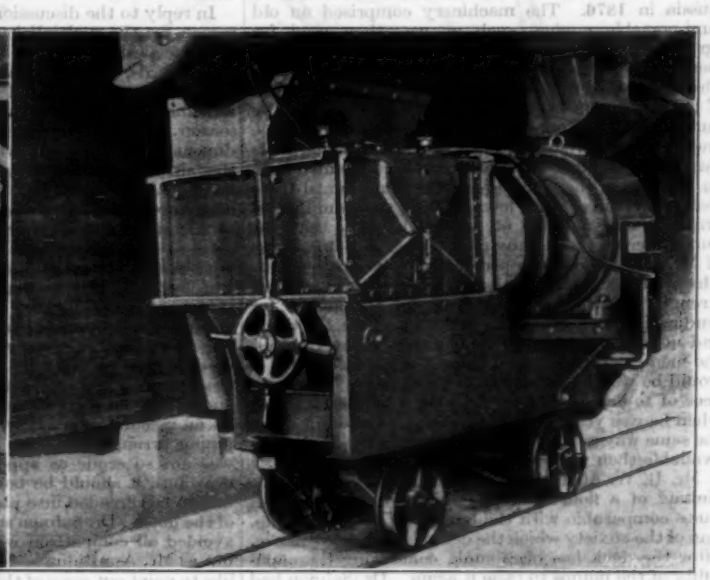


FIG. 88—TRAVELLING ELECTRICALLY-DRIVEN CLINKER CRUSHER

Institution of Mechanical Engineers

FLOATING DOCKS.

THE Institution of Mechanical Engineers met on Friday, the 18th inst., at Storey's Gate, to discuss a paper on "The Machinery of Floating Docks," by Dr. E. H. Salmon, an abstract of which we commence to print on page 575. The President, Captain Riall Sankey, took the chair, and there was an unusually large attendance of members.

Before the ordinary business of the meeting was commenced the President announced the death of Mr. E. Windsor Richards, who was President of the Institution in 1896–97, and of Sir Douglas Fox (obituary notices of both engineers appeared in THE ENGINEER of November 18th), and said that letters of condolence were being sent to their relatives by the Council of the Institution.

In presenting his paper, Dr. Salmon had recourse to lantern slides to a considerable extent, and began by illustrating the spectacular effect of docking a large ship with a series of pictures showing the raising, on a floating dock, of the U.S.S. Illinois. He then gave an outline of the principles involved in the design of a dock with the object of reducing to a minimum the amount of pumping required to lift a ship, and exhibited a number of slides showing the interior working parts of floating docks and their machinery. The figures of costs given in the paper would not, he said, hold good nowadays, but were still useful for comparative purposes. In this connection it was important to bear in mind the relation between the capital cost of the hull of the dock and the cost of pumping it out. The business of the dock would naturally have an influence on such considerations, as, if it would not be used very often, it might be economical to save money on the structure at the expense of having to spend more on pumping than would be the case if the most efficient type of hull were adopted.

The President invited Mr. H. J. Deane, the chief assistant engineer, Port of London Authority, to open the discussion. Mr. Deane said that he was specially interested in the apparatus for controlling the operation of the dock, and commented on its extreme delicacy and complication, but appreciated that such appliances were of vital importance to floating docks. He thought that there was room for improvement in the pneumatic water level indicator, and suggested that it should be possible to make the instruments smaller, so that they could be grouped within a lesser compass. It was possible, he thought, that there were other means of indicating water levels which might be better than that described by the author. The rate of flow through a Venturi meter, which was controlled by the water level, might, for instance, be used to give the indication. As an example of the electrical system of distant indication, Mr. Deane mentioned the electrical thermometers which are used for the cold stores of the London docks. They have leads ranging up to 1300ft. or 1400ft. long, and give a rough guide as to the temperature in the store; but the system was not, he thought, accurate enough for indicating the water level in the various compartments of a floating dock. Mr. Deane asked why it was necessary to have as many as ten pumps in a single dock, and said that he would prefer to reduce the complication of the plant by putting in fewer pumps and extending the piping system. He also asked if the valves were used to throttle the flow of the pumps, either on the delivery or suction sides, as he would expect the pumps to lose their water when not working at full capacity, or were the pumps regulated by throttling the engine? In discussing the auxiliary machinery Mr. Deane said that he had not yet found an electric capstan fitted with a really satisfactory slipping clutch, to prevent the motor being pulled up when the rope became so taut as to stop the capstan, but thought that electric capstans were possibly adopted on floating docks in preference to hydraulic capstans on account of the difficulty of finding accommodation for an hydraulic accumulator. As a matter of fact, an accumulator was not really necessary in an hydraulic installation, and if modern multi-stage centrifugal pumps were installed in place of the old-fashioned reciprocating pumps an accumulator was actually useless. On account of the drooping pressure characteristic of centrifugal pumps, the accumulator would remain either at the top or the bottom of its stroke, and would only float on the mains if the conditions were exactly those for which it had been loaded. There were, he said, several large multi-stage pumps working on hydraulic systems without accumulators, and some were now being installed at the London docks. It would, he thought, be worth while to consider the use of hydraulic power for operating the gear of floating docks, while the oil transmission system might prove very convenient

for so controlling the pump valves that they might be partially opened or closed.

Mr. G. P. Mair spoke at some length on the relation between the time occupied in pumping out a dock and the power required for the operation, and explained how important it was so to design the pumps that they absorbed as nearly as possible the same amount of power throughout the varying conditions of a docking operation. If the dock was to be worked in connection with a shore supply of electricity tapped off an alternating system, which meant that the pumps would run at a constant speed, the calculations as to the power required by the pumps had to be made very carefully. On the other hand, with steam-driven pumps there was much more latitude; a fact that was emphasised by a case he remembered in which the guaranteed rate of pumping was exceeded greatly. The boilers of that installation had been proportioned to supply steam for all the services on the dock, but during the trials they were devoted solely to the pumping engines. No trouble was experienced, he said, with the pumps of floating docks losing their water through sucking air. It was not necessary even to provide charging apparatus, and a dock could be drained out almost dry by means of the main pumps.

Mr. L. E. Clark, Messrs. Clark and Standfield, when called upon by the President to join in the discussion, said that he thought it would be hardly appropriate if he discussed the paper, but he would be very pleased to tell some of his early experiences with floating docks. The first, he said, was one he took out to Russia in 1876. The machinery comprised an old semi-portable engine, such as was then used for agricultural purposes, connected with the pumps by means of belting and cog wheels with hornbeam cogs. The cogs were an incessant cause of worry on account of their habit of dropping out of their sockets. The pumps had impellers with plain cast iron radial arms, and these also broke off; but it was rather remarkable that each shedding of an arm was accompanied with an increase in the efficiency of the pump, until there were only three arms left. Below that number of arms the efficiency fell off again. In those days the pumps were controlled by plug valves, and it was one of Mr. Clark's jobs to operate the valves, a business which meant bracing oneself up and exerting all the strength possible. There were no telephones for sending instructions to the distant parts of the dock, and none of the modern refinements. Nevertheless, the men got through with their jobs—a fact which it would be well to remember in these days. The engineer of to-day should not lose sight of the fact that when he was yet quite young things went on in much the same way as they now do, although the appliances available then were far more crude.

Mr. R. W. Allen spoke of the impressiveness of the sinking of a floating dock, which was, he thought, quite comparable with the launching of a large ship, and of the anxiety which the designer must experience, after the dock has been sunk, concerning the capability of the pumps to raise it again. Dr. Salmon had said that the efficiency of centrifugal pumps as determined on the test bed was very different from their efficiency averaged over a lift, but there was no reason why that should be the case if proper precautions were taken. The explanation of the author's assertion was probably to be found in the lay-out of the piping, which, Mr. Allen thought, might be greatly improved. Specially was it necessary to provide more room under the suctions of the pumps if whirlpools and their associated losses were to be avoided. Again, the bell mouths of the suction pipes were very crude and could be greatly improved upon. Mr. Allen promised to contribute to the "Transactions" of the Institution his idea of the proper shape for suction inlets. In his paper Dr. Salmon mentioned that the pumps of floating docks were *generally* of the vertical spindle type, but Mr. Allen considered that it was imperative that they should *always* be vertical. In support of his contention he recounted how Captain Sankey and himself had received a telegram, some thirty years ago, running, "Come quickly, the dock is upside down." The dock, which was stationed somewhere abroad, was equipped with horizontal pumps and on that account they were so high up in the dock that leaks in the suction piping prevented the pumps from getting their water. The dock was, however, ultimately salved by stopping air leaks in the pipes. Mr. Allen did not think that Mr. Deane's scheme for diminishing complication, by reducing the number of pumps, was the right one; it would be better to multiply the number of pumps and have no pipes at all.

Mr. Asa Binns said that he was more familiar with the dry dock than with the floating dock, but in view of the predominance of the former type he would like to draw a few comparisons. There were, he said, throughout the British Empire ten dry docks to every floating dock, and the waters where floating docks were most conspicuous were the Baltic, the American seaboard, and some inland seas. The floating dock certainly had the great advantage of mobility, so that, in the event of it not attracting sufficient patronage in one site, it might be moved to another at no very great cost. Again, in situations where the level margin near the waterside was narrow it might be impracticable to excavate a dry dock, whilst a floating dock could be berthed outside. Or the ground might be of such a nature that it would be very difficult to put in the foundations of a dry dock. On the other hand, there were cases, of London for instance, where a site for a floating dock could not be found within 50 miles of St. Paul's, but where such a dock as the King George V., capable of berthing a 30,000-ton liner, could be constructed. The dry dock, he thought, also had an advantage in the matter of safety, and when the great value of a vessel on the chocks was compared with that of the dock itself, that was a very important matter. It was possible, also, to arrange the pumping plant of the dry dock in a most efficient manner. At the King George V. dock there was no piping and the pumps had direct connections, on either side, 48in. in diameter. They were of the horizontal type, were driven by 820 horse-power electric motors, and could pump out 3½ million cubic feet of water in three hours. It was also possible to have a travelling crane weighing some 200 tons and capable of reaching right over the dock, running alongside, while such services as the compressed air supply were merely tapped off the local mains. Mr. Asa Binns did not seem to think that the leading-in gear described towards the end of the paper was a very practical idea which would commend itself to dockmasters.

Mr. E. R. Dolby gave a brief description of a pneumatic depth-recording device, involving the use of a small diving bell, which he had found quite satisfactory; while Mr. Peter said that an electrical form of recorder is used at the locks of the Panama Canal; and Mr. E. White asked what would be the effect on a ship lifted by a dry dock if the dock were collided with.

In reply to the discussion Dr. Salmon said that the reason for the multiplicity of pumps on a dry dock was the desire to make the dock self-docking. In other words, the dock was sectionalised, so that any one part could be lifted out of the water by the remainder, and each part was self-contained. Another reason for putting in several pumps was the internal dimensions of the side walls, which put a limit on the size of the individual pump which could be installed. The complication of the control gear was really not nearly so great as appeared to be the case at first sight, and in general practice it was not necessary to manipulate the controls except at certain critical stages of a lift, such as when the pontoon was just awash. The greater part of the regulation of the pumps was effected at the engine, but it was necessary to throttle them down somewhat in order to get out the last of the water. Although he had not used hydraulic capstans on a dock, it was not on account of lack of accommodation for an accumulator, and in any case an air bottle could be used in place of an accumulator. Mr. Allen had criticised the piping arrangement, but although the arrangement was not so crude as appeared from the small scale drawings, it should be borne in mind that the pipes had to be threaded into place through all the framing of the dock. Dr. Salmon said that he had deliberately avoided all comparison with dry docks in his paper, but as Mr. Asa Binns had raised the subject he would like to point out some of the advantages of the floating dock. In one example, for instance, the manager of a dock got one steamer off on a rising tide and another in its place before the flood was full. A dock at Aberdeen berthed 318 vessels in 308 working days and once had five steamers on the chocks within twelve hours. In the case of a dry dock the smaller the ship which was accommodated the greater was the amount of water which had to be pumped out of the dock; whereas a floating dock required pumping in direct proportion to the displacement of the vessel raised. When once a floating dock was up the floor remained dry, but the bottom of a dry dock required constant draining, and at Devonport the drainage pumps were of 400 horse-power. The main pumps of the Bermuda floating dock were only 600 horse-power. The effects of collision with a floating dock were, of course, entirely dependent upon the circumstances; but he knew of a case where a dock was holed by a steamer and the one man on board alone kept it from sinking with the aid of the dock's own pumps.

In thanking the author for his paper the President remarked that one great advantage of floating docks, as compared with dry docks, was the possibility of exporting them. He announced that Mr. G. R. Sharpley was retiring from the Council of the Institution, and that the Council had appointed Colonel Kitson Clark to fill the vacancy.

SINCE March 1st, 1921, the Federal Power Commission of the United States has authorised the issue of thirty licences involving 1,269,000 horse-power, and twenty-four preliminary permits involving 1,280,000 horse-power, a total of 2,549,000 horse-power. It has already taken final action upon one-third of the applications filed. Several of the applications approved under the Act involve projects for the execution of which specific congressional authority was sought for many years, but never obtained. Notable among them are projects on the Niagara, on the Connecticut River at Enfield Rapids, and on the Coosa River in Alabama. Notwithstanding the industrial depression and the uncertain financial situation, projects aggregating 1,277,000 horse-power and an investment of approximately 100,000,000 dols. are already under construction in New York, Alabama, Wisconsin, Oregon and California.

Rangoon and Its Proposed New Docks.

(Contributed.)

IN 1922 Rangoon will complete seventy years of continuous life under the British flag. Of the town that was attacked and occupied by the British and Indian troops in 1852, save the golden Shwedagon Pagoda, a famous place of pilgrimage, dominating the town from its commanding position, and the Sule Pagoda, almost on the foreshore and now hidden among the buildings of the modern city, but few traces remain. Situated within 30 miles of the Gulf of Martaban, on a peninsula 3 to 4 miles wide, Rangoon, apart from its possession of the Shwedagon Pagoda and though never a royal capital, had come to be regarded by the Burmese kings as a mercantile centre. As long ago as 1790, when a town was well established on the site, the East India Company set up a factory, and traders from all countries were encouraged. In the first Burmese war, 1824, Rangoon was occupied, though it was subsequently evacuated in 1827. At that time it was practically the only port of foreign trade in the Burmese dominions. In 1852 the population of the town, which included people of all Indian races and a few Europeans, amounted to some 25,000. These numbers had grown by 1911 to 293,000; whilst in the recent census of 1921 the figures had increased by 16 per cent. to as many as 339,000.

The story of how the trade of Rangoon and of the province of Burma has grown is almost a romance. Rice has been cultivated for generations in the swampy land of the delta far in excess of the needs of the country, but it is curious to note that in the early statistics, which were doubtless very incomplete and unofficial, no mention is made of rice, the staple food grain of the province and for years past its chief article of export. In an old circular issued in 1858 by a Calcutta firm it is stated that in that year the exports of rice from Rangoon had attained considerable dimensions, and were showing a very rapid increase. They sprang from nil in 1853 to 112,561 tons in 1858. Development of the rice milling trade began in the 'seventies, and, as methods improved, production was increased and trade with Europe developed. Before the great war large exports of rice were made to Germany in connection with its starch and brewing industries. Some two million tons of rice annually and even more have, in recent years, been available for export. Burma's forests of teak have long been famous; and when the old wooden vessels were replaced by iron, teak acquired a new use on account of its qualities, and its popularity with the shipbuilders has become world-wide. The export of teak squares from Rangoon is very considerable. The oil-bearing tract of Burma has been worked by the Burmans certainly since the middle of the eighteenth century, and the coming of the Burma Oil Company, Limited, in the 'eighties and the subsequent wonderful development of petrol and the internal combustion engine have spelt prosperity for thousands. The crude oil is pumped from the fields up country to Rangoon through a pipe line 270 miles long to the refineries situated below the city.

The province of Burma is rich in minerals, and the mining of silver and lead, zinc and copper, is being vigorously prosecuted by the Burma Mines Corporation in the Shan States. During the war large quantities of wolfram were mined at Tavoy and exported *viâ* Rangoon, but with the coming of peace the demand for this mineral has ceased and tin mining is in course of development. Agriculture is being developed on a large scale throughout the province, and the cultivation of cotton, rubber, lac, beans, seeds and grain is everywhere being encouraged. The development of railways has been slow, and so far only some 1600 miles have been constructed. As a result, however, of rice control in 1919, large profits have accrued to the country, and the wise expenditure of this capital on railway and road extensions will benefit the cultivator, and, it is hoped, add largely to the volume of exportable produce from the province.

Rangoon, which is now the principal port in Burma, became a regularly established port in 1853. For many years afterwards a Government flotilla was kept up for the conveyance of troops and Government stores only on the Irrawaddy River, together with a dockyard and workshops in Rangoon for repairing the steamers and flats, &c. Both flotilla and buildings were taken over in 1864 by the Irrawaddy Flotilla Company, established in Glasgow, which has now a very large fleet of river craft.

Rangoon became the seat of local government in 1862. It had made but moderate progress as a port during the preceding ten years of British occupation. A lightship had been placed at the mouth of the river (in June, 1852), and a wooden wharf had been built in the port itself (in 1859). The earliest statistics readily available are for the official year 1861–62. In that year the receipts of the Rangoon port fund, including Rs. 5174 wharfage, aggregated Rs. 60,072, "showing an increase of nearly 100 per cent. over the previous year"; and the expenditure amounted to Rs. 44,940, most of which was on account of establishments, stores and repairs to the light-vessel and boats. The number of vessels which entered the port

in 1861–62 was 438, with a tonnage of 157,472, equal to 340 tons per vessel. The bulk of the trade at this time was coastwise, but few vessels entering the port direct from foreign countries; and most of the goods were landed on the bank of the river from cargo boats. The value of the imports in the year above mentioned was Rs. 1,23,87,679, and of the exports Rs. 1,40,26,752, a total of Rs. 2,64,14,431.

The wharves and jetties were situated on the foreshore known as the Strand bank, which was supervised by the Magistrate up to July, 1874, when it was placed in charge of the President of the Municipality. Almost all the revenue derived from it for about twenty-three years had been appropriated for the benefit of the town, a very small proportion having been expended on port improvement. In June, 1876, the management of the Strand bank, which was reserved from municipal limits under a special notification at the date of the inauguration of the Municipality, was handed over to a committee consisting of the Master-Attendant, Collector of Customs and the Executive Engineer, and all the revenue collected was expended in providing accommodation for boats and in improving the foreshore generally. In June, 1878, the Governor-General in Council approved the proposal to create a trust, and a corporate body known as the Commissioners for the Port of Rangoon was formed with effect from January 1st, 1880.

When the Commissioners took charge there were three fixed jetties and one pontoon jetty for the accommodation of sea-going steamers, three small fixed jetties for boat traffic, and two small jetties for passengers. For the inland traffic the Irrawaddy Flotilla Company had three small pontoon jetties, but there was no public jetty accommodation available. There were no moorings in the port. In 1880–81 the number of vessels entering the port was 874, of which 478 were steamers, 199 European sailing vessels, and 197 native craft with a total net tonnage of 598,303. In 1920–21 the number of vessels entering the port was 1303 steamers and 398 native sailing vessels, with a total net tonnage of 2,300,513.

Statistics of the tonnage of goods landed and shipped in 1880–81 are not available, but the value of the trade of the port was Rs. 10,38,68,938. In 1920–21 the sea-borne trade aggregated 4,037,923 tons, while the value was Rs. 87,95,43,447. The export trade alone totalled nearly three million tons, whilst imports exceeded one million tons. In addition, there was the continually expanding inland water-borne traffic, of which the Irrawaddy Flotilla Company has the greatest share, with its volume in 1920–21 of some 765,000 tons.

Mention has not hitherto been made of the immigrant traffic of the port of Rangoon to and from India. This is of a seasonal character, Burma being largely dependent on Indian immigrants for the bulk of her labour supply. The number of immigrant passengers through Rangoon exceeds 250,000 in each direction yearly, and complaints of poor treatment and of delays on arrival owing to medical and other inspections have been a subject of agitation for many years. Much of the trouble has been admittedly due to the inadequate landing arrangements provided in the port, and there is no doubt that the conditions for third-class passengers have been distinctly unfavourable.

The administration of the port is vested, under the Rangoon Port Act, in a representative public body, the Commissioners for the Port of Rangoon, which has as its present chairman Mr. J. A. Cherry, C.I.E., M.L.C., barrister-at-law, who was appointed to that position in December, 1920. In its early days, the Rangoon Port Commission was administered by a vice-chairman; in 1901, Mr. (now Sir) George C. Buchanan, a civil engineer, became its head, combining the offices of chairman and chief engineer, and this was continued when, in 1915, Sir George Buchanan left for Mesopotamia, until Mr. Holmes retired in 1920. Mr. Cherry's appointment, as a man with business and port experience, marked the separation of the two offices of chairman and chief engineer. The business needs of the port have grown to such an extent that they demand attention separate from the engineering problems with which every port authority has to cope.

Certain existing wharves and extensive foreshore properties were vested in the Commissioners on their incorporation in 1880, and from time to time other properties have been acquired since. The foreshore on the harbour extends over 7200 yards, of which approximately two-thirds is occupied by the Commissioners, and developed for port traffic purposes. The whole is very inadequately served by the single line of the Burma Railways suburban branch, and improvement is impossible as the crowded city impinges upon the foreshore along its whole length. The Commissioners' wharves, jetties and pontoons are becoming inadequate for the port's traffic, and improved and increased facilities for foreign, inland and passenger traffic are imperative. The port of Rangoon consists of the harbour proper, or what may be described as the inner harbour, where the Rangoon River is some 800 yards wide, and where are provided fourteen swinging and eight fixed double moorings for sea-going craft. Views of the harbour and river are given on page 568. To reach the harbour all vessels have to cross the Hastings shoal by the Monkey Point channel, which is maintained by constant dredging, and can be entered at certain states of the tide by vessels up to 33ft. draught, but these deep vessels cannot be accommodated to that draught

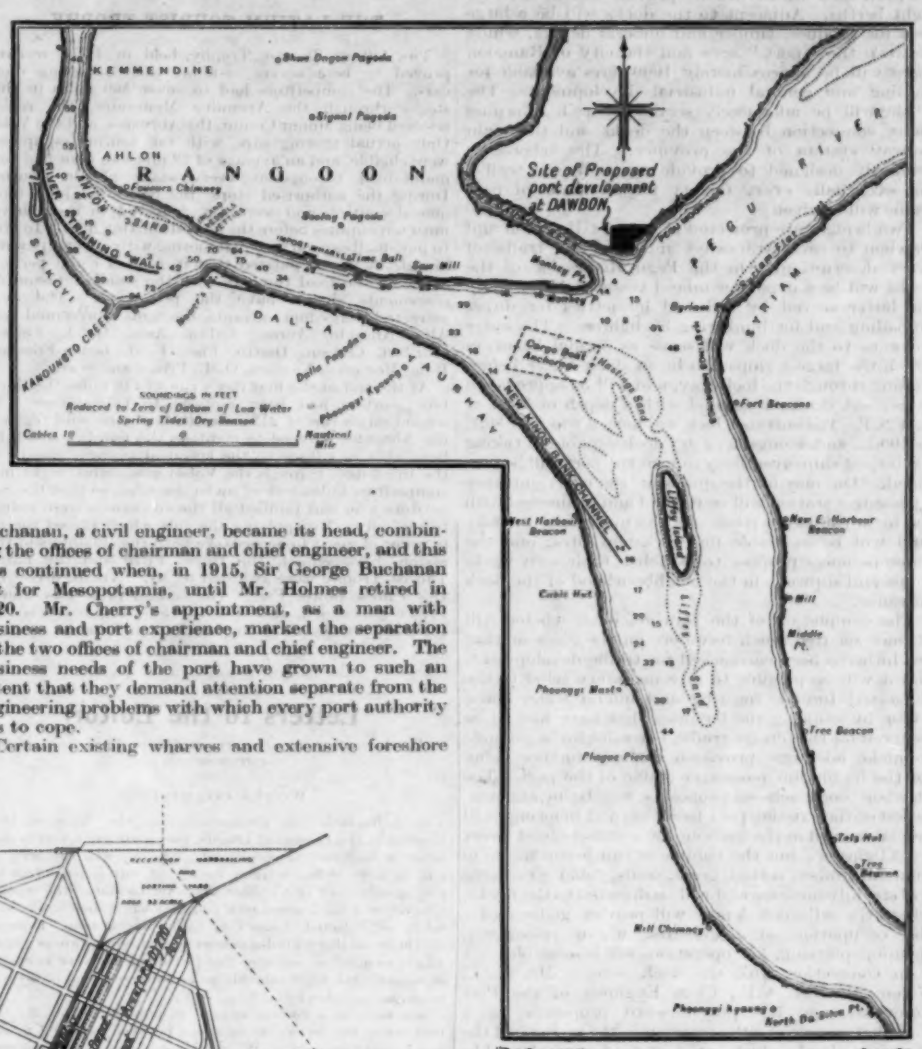


FIG. 2—RANGOON AND PROPOSED NEW DOCK SITE

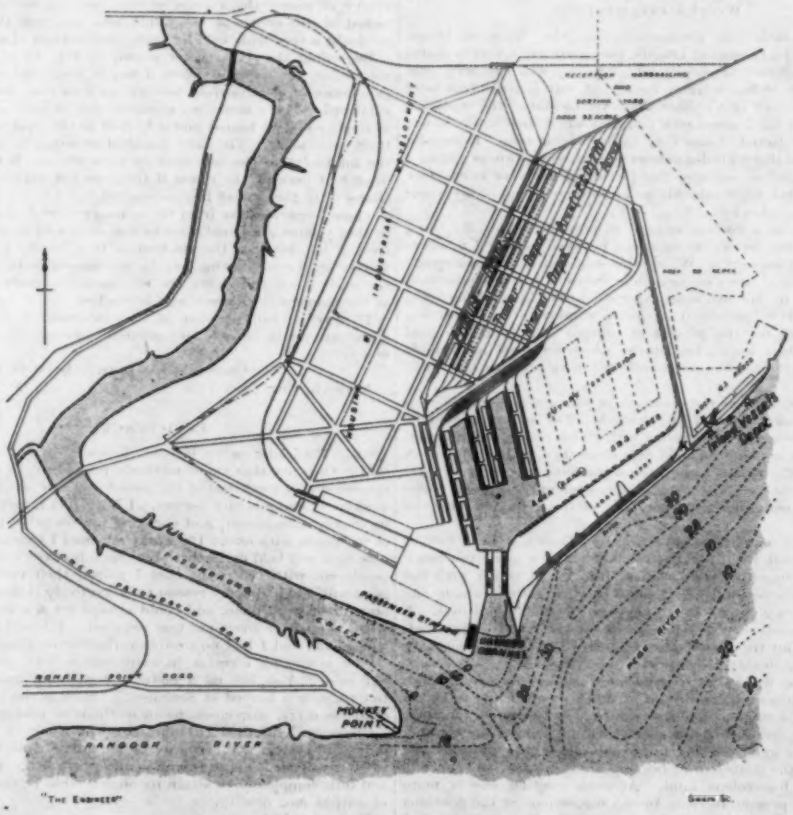


FIG. 1—PLAN OF PROPOSED NEW DOCK AT RANGOON

in the harbour, with a result they are obliged to complete their loading below the Hastings, where the Commissioners maintain five swinging and six fixed moorings. The Hastings shoal is situated below Rangoon at the junction of the Rangoon River, the Pegu River and the Pazundaung creek, and for very many years has been a serious menace to the port of Rangoon. Erosion of the river bank for years has been taking place, and the Hastings shoal has at the same time enormously increased in size. A project of river training walls and dredging to secure a channel through the Hastings shoal was propounded in 1920 by the Commissioners' consulting engineers, Messrs. Meik and Buchanan, which was estimated to involve an expenditure of approximately 2 crores of rupees. The scheme did no more than propose to safeguard the existing inner harbour (the accommodation in which is already overtaxed), and the costly acquisition of foreshore sites now in commercial occupation would have been necessary in addition to provide an extension of port facilities.

Since the war a number of proposals have been made in connection with the port's development, and these have culminated in what may be described as the present chairman's Dawbon dock scheme. Mr. Cherry's scheme of future port development, which has been approved by a Government conference, by the Port Commissioners, and in its general aspects by the Burma Chamber of Commerce, is a complete departure from any attempt to meet the problem of expansion by continuing on past methods. While retaining all the existing accommodation in the harbour and remodelling it to better advantage, it is now proposed to construct deep-water docks, available for entry at all stages of the tide, which will provide for overseas shipping without crossing the Hastings shoal. The land required for the purpose lies immediately to the east of Rangoon at Dawbon. The site, a view of which is given on page 568, is separated from the city proper by the Pazundaung creek, a narrow waterway some 600ft. only in width—

see Fig. 2. On the banks of this creek are numerous mills, on the Rangoon as well as on the Dawbon banks, and railway connection already exists between the provincial main line and Dawbon. The area to be developed approximates 2000 acres and is at present low-lying paddy land entirely utilised for agricultural purposes, which it is anticipated will be inexpensively acquired. Out of this area some 600 acres are earmarked for docks. As a beginning it is proposed to construct fifteen berths for large foreign-going vessels—see Fig. 1. Expansion over the whole reserved area will eventually provide a total of forty-eight berths. Adjacent to the docks will be a large area for produce, timber and mineral depôts, whilst between the "port" area and the city of Rangoon there will be approximately 1000 acres available for housing and general industrial development. The whole will be adequately served by rail, affording direct connection between the docks and the main railway system of the province. The scheme is primarily designed to provide for railborne traffic, but eventually every facility for all kinds of port traffic will be given.

Two bridges are projected to connect Rangoon and Dawbon to carry tramways and vehicular traffic of every description. On the Pegu River side of the docks will be a depôt for inland vessels and for coal; the latter served by rail and by jetties for direct unloading and for bunkering by lighters. The outer entrance to the dock will serve as a tidal basin, in which the largest ships can lie in slack water before passing through the lock-way, and will be approached by a short dredged channel with a depth of 35ft. at L.W.S.T. The entrance lock will have a width of 80ft. to 100ft., and, alongside, a dry dock capable of taking the largest ships ever likely to visit the port will be provided. On one of the quays at the outer entrance a passenger station will be erected and connected with the main railway system. In the immediate vicinity land will be available for workshop sites, and the Commissioners propose to establish their own workshops and slipways in the neighbourhood of the dock entrance.

The completion of the Dawbon dock scheme will at once set free much foreshore on the harbour that has hitherto been earmarked for traffic development, and it will be possible to give necessary relief to the congested Indian, coasting and inland water-borne traffic by utilising the facilities that have had to be reserved for the foreign traffic. It will also be possible to make adequate provision without further delay for the immigrant passenger traffic of the port. The Dawbon dock scheme proposals will be in augmentation of the existing port facilities, and moorings will be maintained in the harbour for vessels to load direct from lighters; but the volume of rail-borne traffic in mineral, timber, cotton, grain, seeds, &c., for overseas will steadily increase and will be diverted to the docks, where the adjacent depôts will provide godowns for the occupation of merchants, where re-bagging, cleaning, pressing, &c., operations will be possible.

In connection with the dock scheme Mr. E. C. Niven, M. Inst. C.E., Chief Engineer of the Port Commissioners, has put forward proposals for a modified scheme of river training in the vicinity of the Hastings shoal, which, at a cost of some 30 lakhs of rupees only, will, within seven years, restore the area lost by erosion and will improve the channel into the harbour by contracting the width of the Rangoon River. His scheme will, it is anticipated, be all that is necessary for the maintenance of the inner harbour, and will be in substitution of Messrs. Meik and Buchanan's two crores project.

A noteworthy feature of the new dock scheme is that it avoids the necessity for vessels crossing the Hastings shoal and the cost of making and maintaining a deep-water channel across it and into the inner harbour, which would involve large expenditure without providing any new source of revenue or increasing accommodation in the port. It is estimated that the Dawbon dock scheme will more than pay for itself, and will provide for unlimited and inevitable expansion of provincial trade. The scheme will directly benefit the cultivator and, it is anticipated, will have an immediate effect in a reduction of shipping costs. It is being projected in close association with the Rangoon Development Trust, which, for its part, will undertake development for housing and industrial purposes. The Burma Railways Company is wholly in favour of the project, as it will provide for railway expansion in a manner quite impossible in the present port of Rangoon. The Government conference, presided over by the Development Commissioner, expressed unanimous approval of the project after a very careful discussion. The Port Commissioners, meeting after the Government conference, unanimously accepted the general scheme and have approved of the necessary preliminary works, such as land and river surveys, substrata borings, tidal and current observations, and the preparation of a provisional lay-out. These works are now actually in hand, but it is anticipated that two years must elapse before actual construction can commence, and that it will be seven or eight years before the new dock will be in such a condition as to receive shipping. When, however, the growth of Rangoon in the past generation is visualised, the necessity is obvious for undertaking a generous scheme of dock development at the capital of a province with great capacity for expansion in every direction. Mr. Cherry, who has had in the elaboration of his project the assistance of Mr. E. C. Niven and the co-operation of Mr. C. Morgan Webb, C.I.E., I.C.S., chairman, Rangoon Development Trust, and Mr. H. V. Lanchester, F.R.I.B.A., town-planning expert, has, with courage, enterprise, and foresight, produced proposals which, when completed, will, it is anticipated, place Rangoon in the select list of the world's best equipped, most efficient, and most prosperous ports.

THE LATIUM TOURIST TROPHY.

The Latium Tourist Trophy, held in Italy recently, proved to be a severe test for the competing motor cars. The competitors had to cover 560 miles in three stages through the Apennine Mountains, the regions selected being Mount Cimini, the Abruzzes, and the Volsci. Only actual touring cars, with full touring equipment, were eligible, and an average of 28 miles an hour had to be maintained throughout every stage of the journey. During the authorised stops the cars were kept under official control, and were not delivered to their drivers until ten minutes before the official starting hour. In order to put small cars on an equal footing with big and powerful models, it was stipulated that in case of equal performances on the road the cars with the smallest piston displacements should have the preference. The event attracted thirty-four entrants, the firms represented being Alfa, Ansaldo, Aures, Ardita, Asso, Buick, Ceirano, Chiribiri, Citroen, Diatto, Fiat, Ford, Isotta-Fraschini, Itala, Mercédès, Nazzaro, O.M., Prince and Scat.

At the end of the first day's run of 146 miles the thirty-four starters had been reduced to twenty-four. The second day's run of 212 miles through the wild region of the Abruzzes reduced to eighteen the number which had been able to adhere to the specified average speed. On the third day, through the Volsci mountains, eight more competitors failed to live up to the rules, so that the competitors who had fulfilled all the conditions were reduced to ten only. By applying the rule which placed the cars in order of merit in accordance with the smallness of their piston displacement, the Royal Prize and the Latium Tourist Trophy were awarded to Mr. Cerboni, driver of a 10–15 horse-power Fiat. The second prize was won by Prince Lancellotti, also on a 10–15 horse-power Fiat, and the third prize went to Mr. Lotti on an Ansaldo.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

WORKS COMMITTEES.

Sir,—Recently, in commenting on the Mansion House meeting of the Industrial League, you made some very truthful remarks on excess of propaganda. As one who has been, and still is, more or less actively associated with independent local propaganda work of a similar character to that of the organisation referred to, I agree with you that while such work cannot safely be neglected, it can very easily be overdone. Especially so if here and there it is discounted by that type of works manager who is so much an engineer that he cannot find time to consider adequately the most valuable and interesting item in his whole plant, namely, his men.

Necessary as a certain amount of public work is, the thing that really matters is the relations between men and management inside the works. When all is said and done, the average working man's views on economic subjects will be influenced much more by his own shop experience than by what he hears or reads. It is possible that many employers are neglecting opportunities for the growth of mutual education and good feeling in their works, two things which form an incalculable asset to any manufacturer—and, one may add, to his workpeople.

Lamentations over the cessation of personal contact between employer and employed are rubbish. The employer cannot, of course, be on intimate terms with all his people individually, but most of us can do a good deal more than we have done. A monthly talk with a committee comprising an elected representative from each section or department has great possibilities for enlightenment, not only of the men, but also the employer.

And since committees have been mentioned, it is as well to remember that they, like propaganda, can be made too much of. Any committee which comes into direct touch with the management demands the very best attention which the directors can give it. It is of no use to send substitutes. A director himself should be present or the value has disappeared. This takes up time, and must therefore be strictly limited to meetings which may be considered indispensable.

In a works within the writer's knowledge where relations are of a very pleasant description, and where efficiency is by no means low, a single committee suffices. It is elected annually, appoints its own chairman, meets monthly, forms the channel by which suggestions for improved plant or conditions are brought to the management (an important matter), and controls the works benevolent fund. At each meeting one or more directors is present to reply to the suggestions of the previous month, to hear anything that a representative has been requested to mention, and to have a frank talk on the business enterprises of the firm, after which the committee is left alone with its chairman. One feature is, I think, a *sine qua non*, and that is that no trade union matter of any description is discussed, this being reserved rigidly to the shop steward or stewards concerned. The committee is therefore elected without reference to any trade union, and does not feel weighted by a sense of responsibility in that direction.

I have ventured to write this somewhat long letter because whilst there is much public speaking of the necessity for good will and co-operation and the rest of it, it is doubtful if all possible efforts privately are being made to achieve those very desirable influences. It is the efforts in one's own works that count both there and outside. If it is timorously suggested that the enlargement and strengthening of trade unionism through the formation of the Amalgamated Engineering Union will swamp all such efforts we may answer that it was the very size of the Triple Alliance which prevented the projected strike last spring. The bigger the association the greater the difficulty of securing unanimity. It is fairly safe to say that anything securing a definite majority of members' votes in the A.E.U. really will deserve attention, which has not always been the case with single trade unions. Much more could be said, but I must already have outstayed my welcome.

Robt. True.

Peterborough, November 22.

APPROXIMATE FORMULÆ.

Sir,—Are not such "approximations" as those of Mr. James just as troublesome to remember as the "true" formula? A table of logs. overcomes all the difficulties of fractional root and powers, thus—

$$\text{Log}\left(\frac{V}{v}\right) = \left(\frac{(\text{Log }(G + 14.7) - \text{Log. } 14.7)}{1.3}\right).$$

V = total volume; v = compression volume.

Like most other engineers, I suppose, I often use approximations, but commonly evolve them on the spur of the moment for mental use, of the nature of Watt's $\frac{3}{4}$ instead of $\frac{\pi}{4}$, except in the case of very difficult mathematical formulæ which practical men cannot usually handle. As a general rule, it is usually easier to remember the basic principles and recall the correct formula than to recall an "approximation" to which there is no memorial aid.

Angmering, November 19th. Geo. T. Pardoe.

RELATIVITY.

Sir,—Following the idea that in gravitation and acceleration the same function—that is, mass—occurs, Einstein has brought these two into a closer relation in his principle of equivalence that says: The one may be replaced by the other.

I think it would make the theory more homogeneous if we said: Gravitation *is* acceleration. That would mean that the earth was expanding, the diameter growing with an accelerated motion. Such expansion would be noticed. But if all matter were expanding at the same rate there would not be any way of noticing it. (Poincaré has pointed this out already.) This would also explain the attraction of earth and sun, and in general the celestial bodies. If both are expanding, their near surfaces would come nearer. So a force would be necessary to hold them apart, which means they appear to attract each other. This force is supplied by centrifugal force. This would do away with the old theory of attraction at a distance without intervening medium.

L. A. W van der Lee.

Delft, Holland, November 18th.

ELECTRIC RIVET HEATERS.

Sir,—In your issue of October 14th last you described methods of electric welding as exhibited at the recent Shipping and Engineering Exhibition at Olympia. The writer has an opportunity of seeing the various electric welding operations mentioned in this article at the Exhibition, and feels that there is no doubt a very wide field for many applications of same.

Regarding the rivet heater shown in Fig. 62 of the article mentioned, the writer wonders if any of your readers have any experience of electric rivet heaters such as that described and exhibited. There seems no question that a very good supply of rivets could be heated and delivered to the riveting machines from such plant. The only doubtful question is in regard to the limitation to the safe heat on such rivets. Is there not a danger of burning the rivets if they are left between the electrodes after the correct heat is reached?

These furnaces differ from the ordinary rivet-heating furnaces in that temperature continues to rise according to the time the rivet is left between the electrode. It is hardly good enough to rely on a river-heating boy to be responsible for turning off the current—if the rivets are not instantaneously required—at the moment the correct heat is reached.

The writer will be glad of any information which correspondents might be able to contribute in connection with this matter.

George Kenworthy, Assoc. M. Inst. C.E.

Norwich, November 17th.

EFFICIENCY.

Sir,—The leader on "Efficiency Methods" in yours of Nov. 11, taking the view that those methods pushed to an extreme are the cause of a great deal of the unrest and bad spirit among the workers is undoubtedly correct. I have had a long experience in works management, and speaking particularly of one period of ten years, with about 120 workers, whom I treated as reasonable men and held an impartial attitude between employers and employed, with the result that I gained their confidence and good will, and had every reason to be perfectly satisfied with the amount of work done, and could always get a willing response when a push or overtime was required. I would not have a time clock, and I had no trouble with time-keeping.

The managing director in conversation five years after I left said, "You left us a body of contented, good workers; to-day, it is a hotbed of Socialism." Such is the result of the ceaseless drive, suspicious, mean methods of management, and "efficiency," so-called but abused. The result of the present industrial system will certainly be its entire break up and ruin to all involved. It is so inhuman and provocative in its nature and fails completely to attain its object—that is, the maximum of output and quality.

November 19th. E. C. S.

THE FIRST LOCOMOTIVE WITH FOUR EXCENTRICS.

Sir,—In the paper read by Mr. Dendy Marshall before the Newcomen Society on the Liverpool and Manchester Railway, it was stated that the Swiftsure, an engine built by Forrester and Co., was the first engine to possess four excentrics. The credit for introducing four excentrics into British locomotive practice is due to Messrs. R. and W. Hawthorn, and the first engine built by them with this improvement was the four-wheeled (0-4-0) engine Comet for the Newcastle and Carlisle Railway. This engine was put into service in March, 1835. On page 50 of Colburn's "Locomotive Engineering and Mechanism of Railways," it is stated that four excentrics were previously used in American practice. Colburn also mentions 1837 as the date when Messrs. Hawthorn adopted them, but this date is an error.

November 21st. E. L. Ahrons.

A Seven-Day Journal.

Labour Co-Partnership.

THE thirty-fifth report of the Labour Co-partnership Association indicates the steady progress which is being made in the adoption of profit-sharing and other forms of co-partnership. Not only has there been an actual increase in the number of schemes in operation, but the idea of united interests embodied in the programme of the Association has in other cases gained acceptance in slightly different forms. This is seen in the increasing desire that all those engaged in an industry should become shareholders; it is also revealed in the rapid growth of Works Councils which take the place of Co-partnership Committees. Reference is made in the report to the new type of profit-sharing included in the recent coal mining settlement, which goes a long way towards a recognition of the principle on which the Association is based. An important event of the year was the successful co-partnership congress held in London, and it has now been decided to hold at the Crystal Palace next June an exhibition of products of firms having schemes of co-partnership, profit-sharing or welfare work in operation. A series of conferences dealing with such subjects as joint industrial councils, education efficiency, recreation, and industry will be held during the exhibition.

Drainage Schemes in England.

THE project for a large reclamation scheme in the Wash area has not found favour with the Ministry of Agriculture. Investigation has, it is stated, shown that the proposition is uneconomical, as the cost of reclaiming the land would be far in excess of its selling value. The Government plan is to undertake a number of small drainage schemes all over the country, and the Unemployment Committee has granted £740,000 for drainage schemes in Great Britain. Every drainage board has been requested to submit schemes, and a large number has already been laid before the Ministry of Agriculture. It is intended that the work will be financed by the Ministry, but that only 35 per cent. of the cost is to be recoverable. The labour employed must consist of ex-Service men to the extent of 75 per cent., and it is hoped that on forestry and drainage schemes at least 10,000 men will find employment in country districts during the next few months.

Mersey Goods Traffic.

THE congestion in traffic which has to cross the river Mersey is an old grievance with business men in the Liverpool and Birkenhead areas. The ferries are quite inadequate to deal with the traffic which is offered, and although various schemes for roadways under the river as well as a bridge have been put forward at different times, there appears to be little likelihood of either of those remedies being adopted owing to the high cost of the works in question. The drastic proposal has now been put forward by Mr. Arthur J. Maginnis that the existing Mersey tunnel should be utilised for goods traffic requirements. It is pointed out by the author of this scheme that the use of the tunnel for passenger railway transport is unremunerative in spite of the large number of passengers that are carried, and that far more important requirements would be served if the railway were abandoned and the tunnel used for purposes of road transport. The scheme is a somewhat revolutionary one. The cross section of the tunnel would give a clear road surface of 26ft. in width, with an available height at the sides of 15ft. The one defect of the scheme is that there is no direct outlet for wheel vehicles to the surface on the Liverpool side, and two short lengths of tunnel to give access to the surface would have to be constructed. This work would involve considerable outlay and occupy a good deal of time, but the opinion is expressed that if the Mersey Railway were to take the matter up seriously it would receive the full support of local corporations and of the Mersey Docks and Harbour Board. The real obstacle to the carrying out of the scheme appears to be the need of making provision for the large passenger traffic of the Mersey Railway, but it is apparently intended that this could be handled by motor omnibus services.

German Reparation Goods.

THE suggestion that Germany, instead of manufacturing goods which are in competition with British products in the world's markets, should be compelled to manufacture for the Allies plant and equipment for works of a capital character is not so practical as might appear at first sight. The scheme proposed is that Germany should undertake the erection of a number of great electric power stations in this country, should carry out the electrification of railways and harbour improvement works. Under this scheme, Germany would be called upon not only to deliver the machinery, but also all the accessory plant. Exception has naturally been taken to this method of obtaining reparation from Germany by those engaged in the British electrical industry. It has been pointed out that not only would work which ought to be carried out by British firms be entrusted to German manufacturers, but they would thereby acquire the additional experience which would enable them to compete more effectively for this branch of trade in the world's markets.

Cargo Carrying Aircraft.

THE Air Ministry has at the present time under construction by the Bristol company an aeroplane of a somewhat novel type. In the design special attention has been directed to load-carrying capacity rather than speed. It is intended to experiment with this machine to elucidate certain points with regard to the actual cost of carrying goods by air, and enthusiasts have suggested that for long distance journeys the cost of carriage—the machine will have a capacity of 3 tons—will be very little in excess of road motor charges.

Admiralty Contract for Scotland.

CONSIDERABLE satisfaction has been caused by the announcement that the Motherwell Bridge Building Company has received a contract from the Admiralty for ten oil fuel storage tanks, each of a capacity of 12,000 tons which are to be erected at Rangoon. Fears had been aroused in the Motherwell district of an increase in the number of unemployed owing to the fact that the company had nearly completed all the work in hand. By securing this Admiralty contract, which, it is stated, has been done in face of keen competition, work will be found for a large number of hands for a considerable period. It is a somewhat noteworthy fact that this company has been running its works on full time throughout the whole of the present year.

Shipbuilding Outlook.

THE grave position of the shipbuilding industry is illustrated by the fact that with the launch of the latest vessel from the Thornycroft yard at Southampton, this company has exhausted the whole of its building contracts, and unemployment among shipyard workers in the Southampton area is likely, in default of new orders, to enter a very serious phase. Complaints are rife as to the large amount of work that might have been carried out by the local shipbuilding industry, which has been obtained by German shipbuilders, and the Government is being severely criticised for having failed to stipulate, in selling German ships handed over to this country, that the re-conditioning must be carried out in British yards.

Speed Record at Sea.

SINCE the Aquitania was converted to the use of oil fuel in place of coal the speed of the ship has been appreciably increased. It is now announced that during the final stages of her last eastward voyage from New York to Southampton, which port was reached on Monday last, the high speed of 26.66 knots was attained, a figure which has only been approached by the Mauretania. Much interest has therefore been aroused as to the possibility of new records being created both by the Mauretania and the Berengaria, which are at present being converted from coal to oil fuel burning for steam-raising purposes.

British Policy in Aviation.

SPEAKING at a meeting of the Women's Engineering Society in London, Sir Sefton Brancker, who has just returned from the conference in Paris, said he found French opinion in favour of a great development of aerial transport. Plans were being made with the aid of the Government for services to Warsaw, Constantinople, Stockholm and Algiers. These were services which, in view of our position in aviation at the termination of the war, should have been put in operation by England rather than France.

Disposals Board and Engineering Industry.

THE strong deputation representing the Machine Tool Trades Association which waited on Sir Howard Frank, the chairman of the Disposals Board, a few days ago had a very genuine grievance to discuss. It is well known that the Disposals Board is selling machinery at prices very much below those quoted by manufacturers of machine tools, with the result that manufacturers are quite unable to compete with the Board. It was stated that over 60 per cent. of the workpeople normally employed in the trade are idle, and the remainder on short time. The orders which have been received by the British machine tool trades during the past year are understood to have been less than one-fifth of the productive capacity of the industry. The object of the deputation was to protest against the huge sales at very low prices which are now taking place. If these sales can be postponed it will give the industry a reasonable chance of acquiring a share of any business obtainable and reduce the percentage of unemployment.

Wages Percentage in Engineering.

THE extent to which the cost of production in shipbuilding and engineering will be affected by the recent reductions in wages may be gathered from a statement issued by the Executive of the Amalgamated Engineering Union. It is estimated that the withdrawal of the Ministry of Munitions 12½ per cent. and the 7½ per cent. bonuses will represent a saving in wages amounting to £50,000,000 a year. This would appear at first sight to be a somewhat exaggerated estimate, and it would be interesting to know the basis on which the computation has been made. There is, however, no difference of opinion as to the hope that this latest wage cut may make it possible for employers to reduce production costs to a point which will lead to an early revival of trade and reduce the large number of unemployed workpeople. The Amalgamated Engineering Union has nearly 90,000 members unemployed at the present time. The percentage of unemployed to total membership being 25 per cent.

Empire Wireless Chain.

DEFINITE contradiction has been given to the rumour that the Government had abandoned the scheme for an imperial chain of wireless stations. It is officially announced that there has been no change in the policy of the Government, and that steps are being taken to erect the stations for which the British Government is responsible without loss of time. The Postmaster-General reminds us, indeed, that the first two stations for which the home Government is responsible—Leafield and Cairo—will be completed and working by the end of the present year. A Commission of experts is now engaged in getting out designs for the remaining stations.

Future of H.M.S. Victory.

IT will be recalled that grave fears were expressed a few months ago that the hull of Nelson's flagship, the Victory, was in such a condition that this historic vessel might have to be broken up. As a result of a careful examination of the hull it is now probable that the Admiralty will decide to find a permanent situation for the ship in dry dock at Portsmouth. One of the docks has indeed been provisionally selected for this purpose, but it is understood that the opinion of experts on the survey recently made of the Victory must be awaited before a final decision is reached. The plan which has been outlined is to float the vessel into dry dock and to build a cradle round the hull.

Dockyards and Disarmament.

STEPS are already being taken at Chatham to provide against the widespread unemployment which would be likely to result if the proposals to suspend all warship construction for ten years were adopted. The Mayor of Chatham has sent a communication to the Admiralty pointing out the disastrous effects which would follow the closing down of the dockyard without any alternative industry being established. A committee of local business men has been formed to evolve a scheme for developing industries on the Medway, and consideration is being given to the improvement of dock and other facilities with the object of diverting shipping from the Thames to the river Medway. A hope has been expressed that the new power station which will be required by the South-Eastern and Chatham Railway when the electrification scheme is carried out will be erected in the Chatham area.

Gold Mining in Wales.

THE gold mining industry has been carried on in North Wales for a considerable period, although only intermittently. It is now some years since operations were suspended at the mine near Dolgelly, from which a considerable quantity of gold was obtained. A fresh attempt is now being made to revive the gold mining industry in this district, mining operations having been again put in hand at the Ologau mines, Bontddu, near Barmouth, which in one year—1890—is said to have yielded £60,000 worth of gold.

Slough Depot Payments.

A QUESTION having been raised in the House of Commons as to the extent to which the Slough Trading Company had discharged the total indebtedness to the Government of £7,000,000 for the purchase of the Slough depôt, it was stated that the Government have already received on account of this sum £4,650,000, which is all that is due to date under the agreement. Of the amount paid, £3,650,000 is for mechanical transport vehicles and spares, and £1,000,000 for the depôt.

Public Works, Roads and Transport Exhibition.

In connection with the congress on "Public Works, Roads and Transport," which has been held during the past week at the Agricultural Hall, Islington, there was also, in the same building, an exhibition dealing with the same subjects. It was a good practical exhibition, and was freer from exhibits having nothing whatsoever to do with the subjects in hand than are many shows of similar character. It was noticeable, however, that though it was intended to embrace public works of all kinds and descriptions,

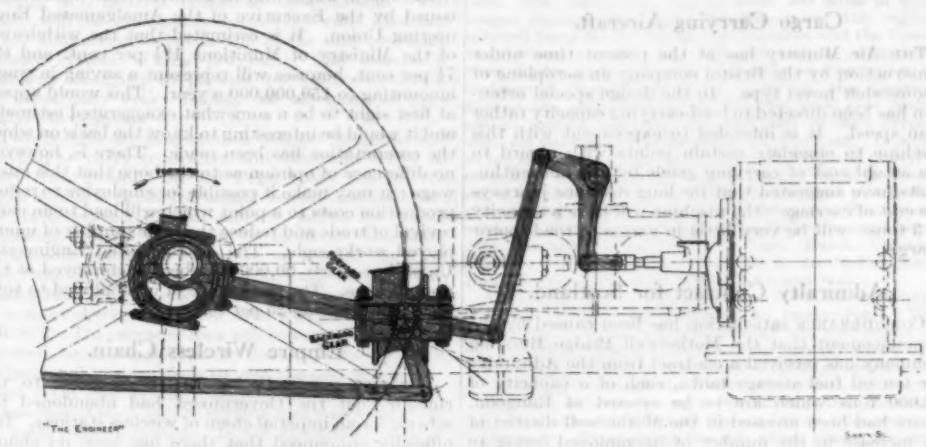


FIG. 1—VALVE GEAR OF MARSHALL 5-TON COMPOUND STEAM TRACTOR

the majority of the exhibits consisted either of material and plant used in the construction of roads or of vehicles intended to run on them when made. In the matter of materials for use in road construction there was, as far as we could see, nothing particularly new. The firms prepared to supply broken granite or other road metal were, as usual, in full force; so, too, were those who specialise in tarry, or bituminous binders, in steel reinforcement of various kinds, and in complete road surfaces of different types. To all of them we have referred in the past and need not do so again, for they are all well known. Mention may, however, be made of Glutrin, the proprietor of which is Mr. Arthur Newsome, of Burley-in-Wharfedale. Glutrin is described as being a product of pine wood, and it is claimed for it that (*a*) it is one of the finest road binders in existence; (*b*) it will bind any class of road material, especially that which is too hard or dense to make into tar-macadam; (*c*) it renders the matrix or binding as hard as the metal; (*d*) it can be laid in any weather, is not subject to waving or internal attrition, is dustless, non-slippery, non-poisonous to fish or cattle, and is not affected by extreme heat or frost; and (*e*) that it costs 5 per cent. more than water-bound and gives double the life. Stonebreakers and pulverisers of various types were exhibited by the Gannow Pulveriser Company, Limited, of Burnley; Goodwin, Barsby and Co., of Leicester; Hadfields, Limited, of Sheffield; H. R. Marsden, Limited, of Leeds; Millars' Timber and Trading Company, Limited, of London; and Robey and Co., Limited; while stone dryers were shown, either in model or in full size, by Electro-metals, Limited, of London; Fleming and Co. of London; Goodwin, Barsby, of Leicester; the Millar Company; Frederick Parker, of Leicester; the Ransome Machinery Company, of London; and Stothert and Pitt, Limited, of Bath.

Of vehicles of one sort and another there was a really fine show, but saving in lighter types of road rollers there was nothing particularly novel in the way of design. Road locomotives or tractors were exhibited by Aveling and Porter, Limited, of Rochester; Charles Burrell and Sons, Limited, of Thetford; John Fowler and Co. (Leeds), Limited; Marshall, Sons and Co., Limited, of Gainsborough; Ruston and Hornsby, Limited, of Lincoln; W. Tasker and Sons, Limited, of Andover; and Wallis and Steevens, Limited, of Basingstoke. All of them were old friends, and most of them exactly as we have seen them before. A new valve gear had, however, been introduced by Messrs. Marshall in a 5-ton compound steam tractor which they had on view. It is illustrated in Fig. 1. The motion of the single excentric is transmitted through the reversing slide by means of the excentric rod. The forward end of the excentric rod moves in an oval path and works a bell-crank lever carried on the top of the crosshead guide. In turn the bell-crank lever operates the engine slide valve. The cut-off of the steam in the cylinder may be varied by adjusting the angular position of the reverse slide. Complete reversal of direction of running is effected by still further extending the angular movement. The gear is operated by means of a lever and notched quadrant plate. In connection with this gear Messrs. Marshall claim that, if wear takes place, the reversing slide is easily adjusted; that the gear offers a much greater area of bearing surface on the slide than there is in the ordinary slot link die, and that an improved steam distribution is obtainable, as it is practically equal at both ends of the cylinder. In passing, we must remark on the high degree of finish given to the various parts of this engine.

Of road rollers of various sizes there were quite a number. They were shown by Allied Machinery Company, Limited, of 132, Queen Victoria-street, London, E.C. 4; Aveling and Porter; Barford and Perkins, Limited, of Peterborough; Charles Burrell and Sons, Limited, of Thetford; the Eddison Steam Rolling Company, Limited, of Dorchester, which exhibited a re-built engine; John Fowler and Co., Limited; the Laffly (England) Company, of 14, Addison-avenue, London, W. 11; Marshall, Sons and Co., Limited; Millars' Timber and Trading Company, Limited, of Pinners' Hall, London, E.C. 1; the Oxford Steam Plough Company, Limited, which also showed a re-built engine; Robey and Co., Limited; Ruston and Hornsby, Limited; and Wallis and Steevens. Four of these engines—those by Aveling and Porter, Barford & Perkins, Ruston & Hornsby & Robeys—possess some distinctly novel features. The Aveling and Porter machine—which is shown in Fig. 2—is of the tandem type. It weighs empty 5 tons, and in working order 5¾ tons, being specially intended for tar macadam and bituminous carpeting. It is steam-driven and is furnished with a vertical fire-tube boiler. The engine has twin high-pressure cylinders

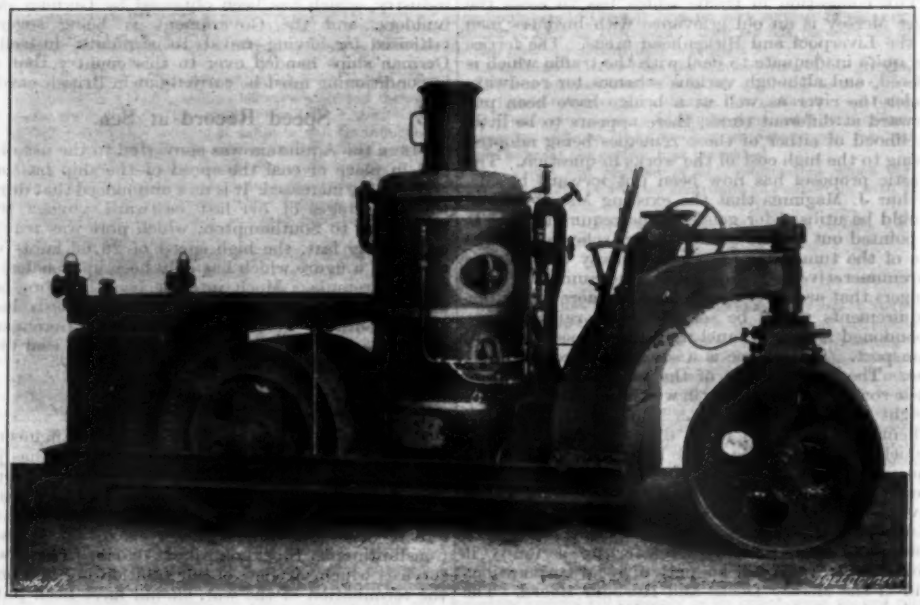


FIG. 2—AVELING AND PORTER QUICK REVERSE TANDEM STEAM ROLLER

fitted with piston valves. The width rolled is 3ft. 7in., and the rollers have wired steel-flanged end plates with wrapper plates. Steering is effected by a small radial engine which is mounted near the driver's seat. The whole gives the impression of being a particularly handy little machine with a very low centre of gravity. The Barford & Perkins roller, Figs. 3 and 4, is heavier altogether, weighing as it does 10 tons empty and 12 tons in working order. Its back wheels are 5ft. 6in. in diameter by 1ft. 8in. face, and its front wheel 4ft. in diameter and 4ft. wide. All three wheels are intended to carry water ballast. By this means the weight of the roller can be increased by some 2½ tons when required. The wheel arrangement is as in the ordinary steam roller, but the engine is of the four-cylinder internal combustion type, made by Brotherhoods, and designed to develop from 35 to 40 brake horse-power on petrol. There are three forward and two reverse speeds, the forward speeds being 1¼, 2¾ and 4 miles per hour, and the reverse speeds 2¾ and 4 miles per hour. A water tank holding 120 gallons can be used for sprinkling the rollers. This tank can also be used for water ballast. The fuel tank will hold 50 gallons, which is enough, so the makers inform us, for a full week's work, the consumption of petrol or paraffin being from 5 to 7 gallons per day on average work. The centre of gravity is kept particularly low by the fact that the sub-frame carrying the engine, gear-box and transmission is underslung. This attribute, the makers point out, makes for steadiness in work and for safety on sloping ground. Differential gear is fitted to the driving wheels, and the short wheel base enables the roller to turn, so we understand, in a circle of 16ft. radius.

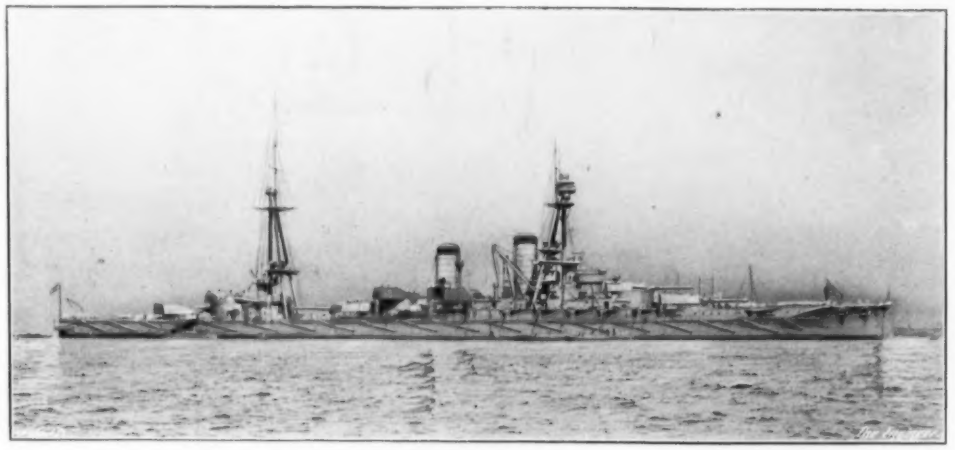
The Ruston-Hornsby roller is also driven by an internal combustion engine, which has two cylinders and is designed to develop 20 brake horse-power when running on paraffin. The weight of the roller in working order is just over 8 tons and the width rolled 5ft. 9in. At each end of a short shaft which takes the drive to the gear-box is a flexible coupling, and one of the special features of the mechanism is that there is a dual clutch which is worked by one control. The makers point out that the provision of two clutches, one for forward and one for backward travelling, obviates the necessity of disengaging the gears when it is desired to reverse, which is a decided advantage when the roller is working on a stiff gradient. The three speeds at which the gears permit the roller to travel are 2½ miles, 1 mile, and ½ mile per hour respectively. There is a pulley for belt work, which can be driven in either direction. The capacity of the fuel tank is 18 gals. and there is also a small tank for containing petrol, which is used for starting up the engine. The roller is illustrated in Fig. 5.

A serviceable looking little roller of novel design was also exhibited by Robey and Co., Limited. It is noteworthy in that its leading parts are identical with those of the firm's steam wagon, so that production is very largely standardised and cost kept down. The roller is of the tandem type with a rolling width of 3ft. 8in. It is manufactured in two sizes, 5 and 6 tons respectively, and is driven by a compound steam engine which develops some 25 horse power with a working steam pressure of 200 lb. per square inch.

Of motor lorries, motor wagons, and self-propelled road vehicles generally there was a great number, and it would be quite impossible to specify them in detail. Some were steam driven, some electrically driven, and some had internal combustion engines. Many of them had been designed for special purposes, such as refuse collection, and many of them had mechanical arrangements for tipping; one, at any rate, being capable of both side and end tipping. Among the makers exhibiting were Atkinson and Co., of Preston; Clayton Wagons, Limited, of Lincoln; the Eagle Engineering Company, Limited, of Warwick; Electricars, Limited, of London; Fodens, Limited, of Sandbach; R. Garrett and Sons, Limited, of Leiston; the General Vehicle Company, Limited, of London; the Lacre Motor Car Company, Limited, of London; Mann's Patent Steam Cart and Wagon Company, Limited, of Hunslet, Leeds; Robey and Co., Limited; Ruston and Hornsby, Limited; the Sentinel Wagon Works, Limited, of London; Slough Lorries and Components, Limited; Stevens Petrol Electric Vehicles, Limited, of London; and the Yorkshire Commercial Motor Company, of Hunslet, Leeds. Trailers of various types and for different

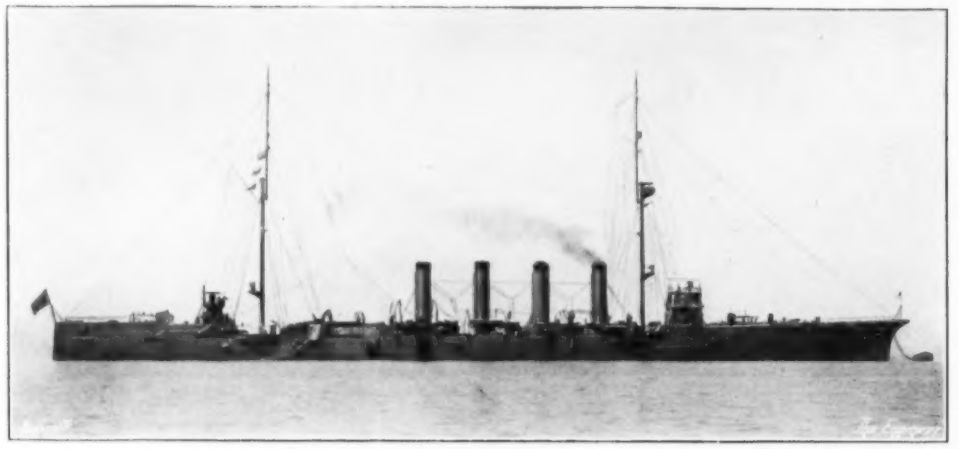
NOTABLE VESSELS OF THE JAPANESE NAVY

BATTLESHIP NAGATO

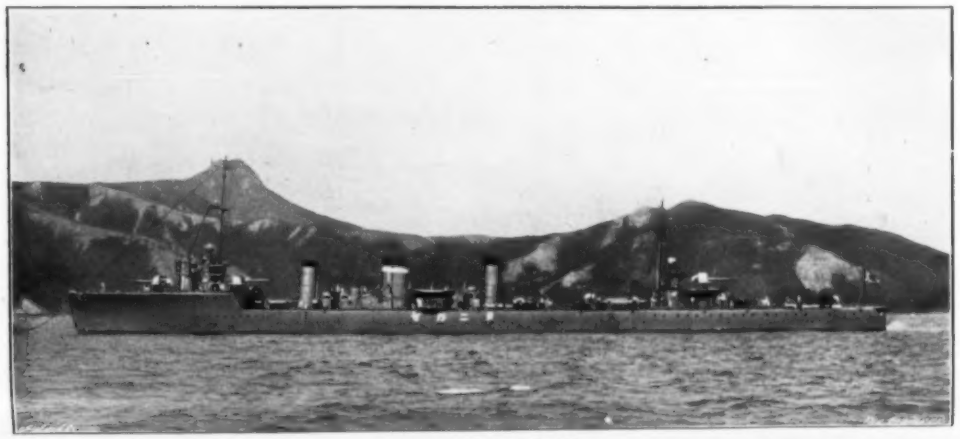


BATTLESHIP ISE

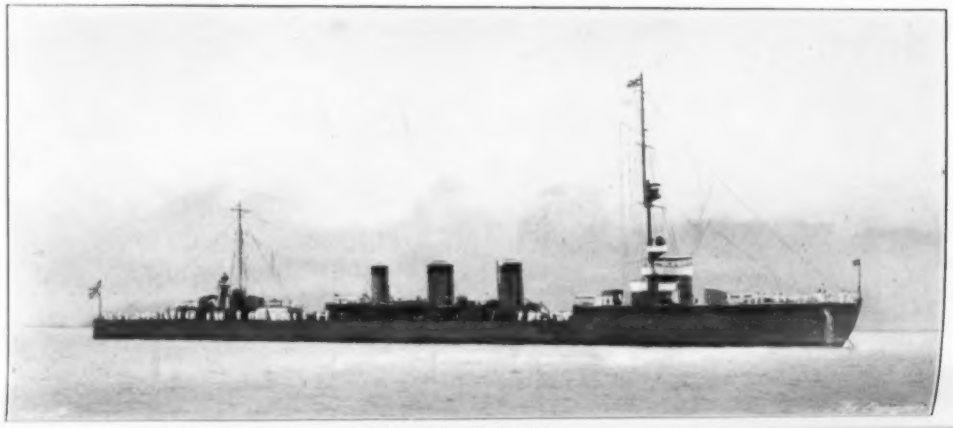
BATTLESHIP YAMASHIRO



LIGHT CRUISER HIRADO



DESTROYER TANIKAZE

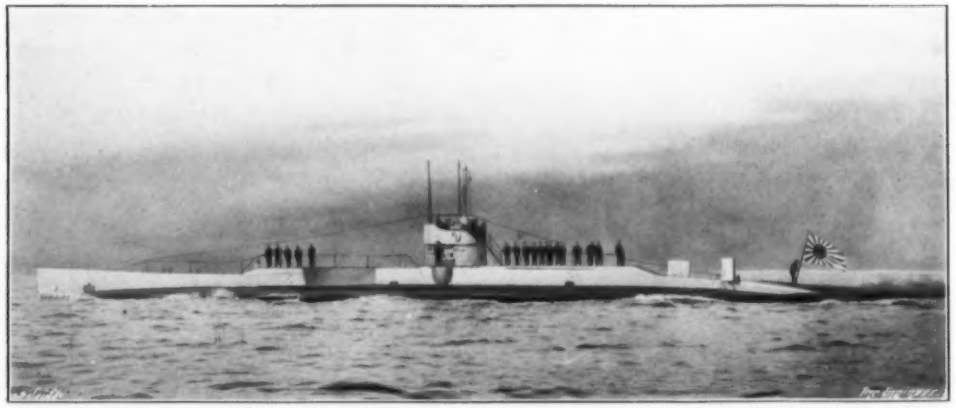


LIGHT CRUISER TATSUTA

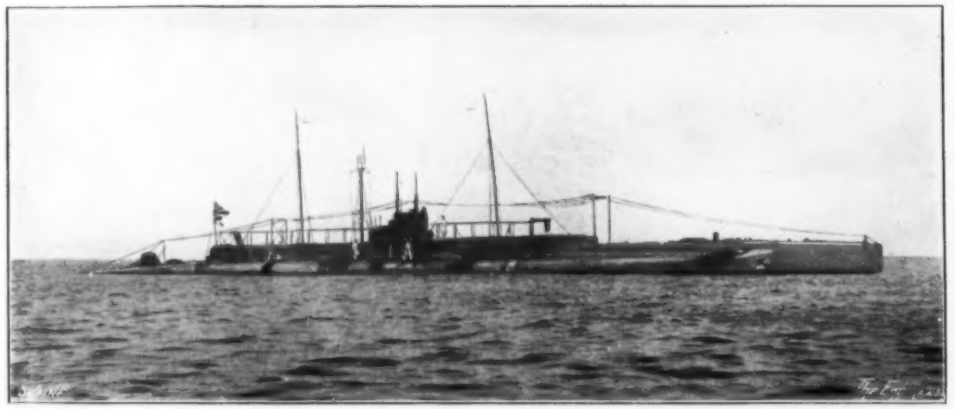
DESTROYER TANIKAZE

DESTROYER AMATSUKAZE

DESTROYER MOMO



SUBMARINE No. 26



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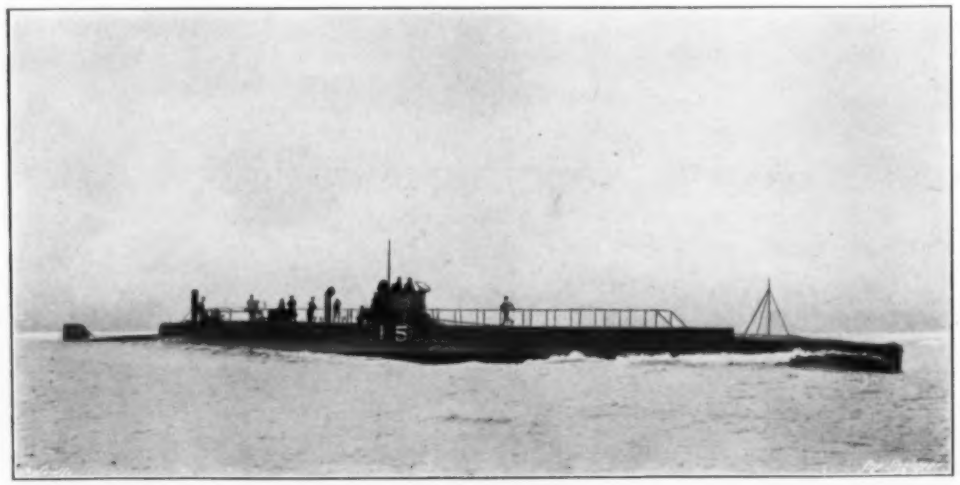

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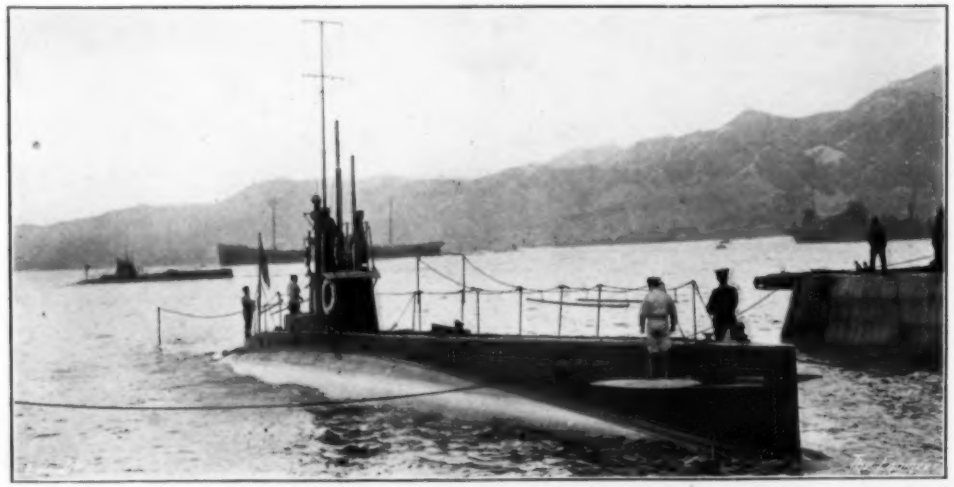


SUBMARINE No. 10

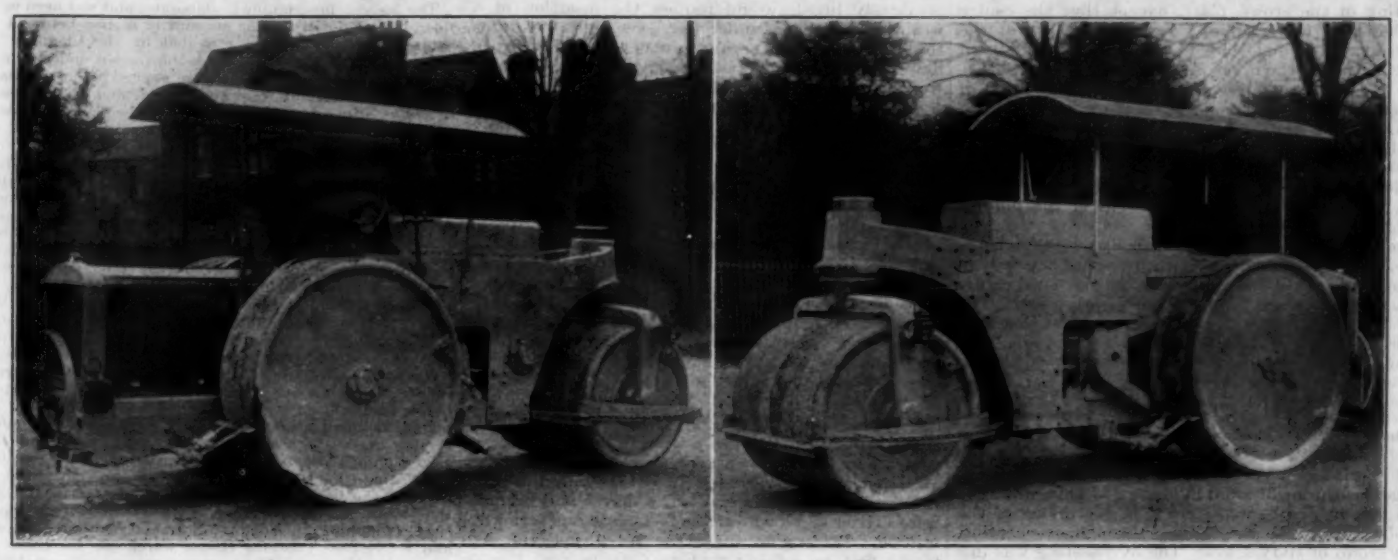
purposes were exhibited by the Carrosserie Latymer, Limited, of London; R. A. Dyson, of Liverpool; William Jones, of London; Robey and Co., Limited; the Sentinel Wagon Works; and Tuke and Bell, of Lichfield.

Of special machines used in the upkeep of roadways, &c., we may mention the gritting machines of John Fowler and Co.; Johnson Bros., of London; and Tuke and Bell. The tar sprayers of Builders and Contractors Plant, Limited, of London; R. S. Clare and Co., Limited, of Liverpool; Fleming and Co., of London; John Fowler and Co.; Wallis and Steevens, Limited; and W. Weeks and Son, Limited, of Maidstone; and the road sweepers of G. R. Archer, of Upper Edmonton; John Fowler and Co.; and the Lacre Motor Car Company, Limited. Motor gully cleansers were shown by the Lacre Motor Car Company, Limited, which also exhibited motor water carts, and the Yorkshire Commercial Motor Company. T. Baker & Sons, of Compton, Berks, also exhibited a street watering cart.

Of concrete and tar-macadam mixing machinery, though perhaps there was not quite so much as at the last exhibition, there was certainly a goodly variety. Many of the machines shown can be used alternatively for making either concrete or tar-macadam, the only difference generally being that for the latter some form of heating is employed. The following firms, with the products of which we dealt in a special Supplement last week, were represented:—The Australia Concrete Machinery and Engineering Company, Limited; the British Steel Piling Co., Limited; Frederick Parker; the Ransome Machinery Company, Limited; and Stothert and Pitt; and mixers of various types were also shown by Builders and Contractors Plant, Limited; R. S. Clare; Goodwin, Barsby and Co.; C. H. McGuinness and Co., Limited, of Westminster; Millars' Timber and Trading Company, of London; Orde and Maddison, Limited, of Darlington; and Geo. Waller and Son, Limited, of Stroud, Gloucester. Concrete block-making machines were also shown by the Australia Company, Stothert and Pitt, and Geo. Waller and Son, Limited.

Noteworthy exhibits were three huge steam shovels or navvies. One was British, that made by Ruston and Hornsby, Limited, and it was a very fine piece of work; while the other two came from across the Atlantic, one being shown by the Millar Company and the other—an Erie shovel—by Muirhead, McDonald, Wilson and Co., Limited, of Parliament-street, Westminster.

Of miscellaneous exhibits there were many, but space prohibits us from doing more than mention a few of them. Wagon loaders are coming more and more into favour as labour-savers. There were three at the Exhibition, all, be it said, of foreign origin. They were shown by the Allied Machinery Company, Limited; the Millar Company; and Hugh Wood and Co., of London and Newcastle-on-Tyne. The last-named firm, it may be mentioned in passing, also exhibited a model of an apparatus for separating stone from coal by centrifugal force, an apparatus which is said to do away with picking belts. An interesting pump, through which all sorts of solids were being passed, was shown by the Unchokeable Pump Company. British Electric Vehicles, Limited, of Southport, had on view some examples of its small electric trucks, which have recently been described in our columns. The Hornsby runabout electric crane, which we have also described lately, was there too.



FIGS. 3 AND 4—BARFORD AND PERKINS 3-WHEEL WATER BALLAST MOTOR ROAD ROLLER

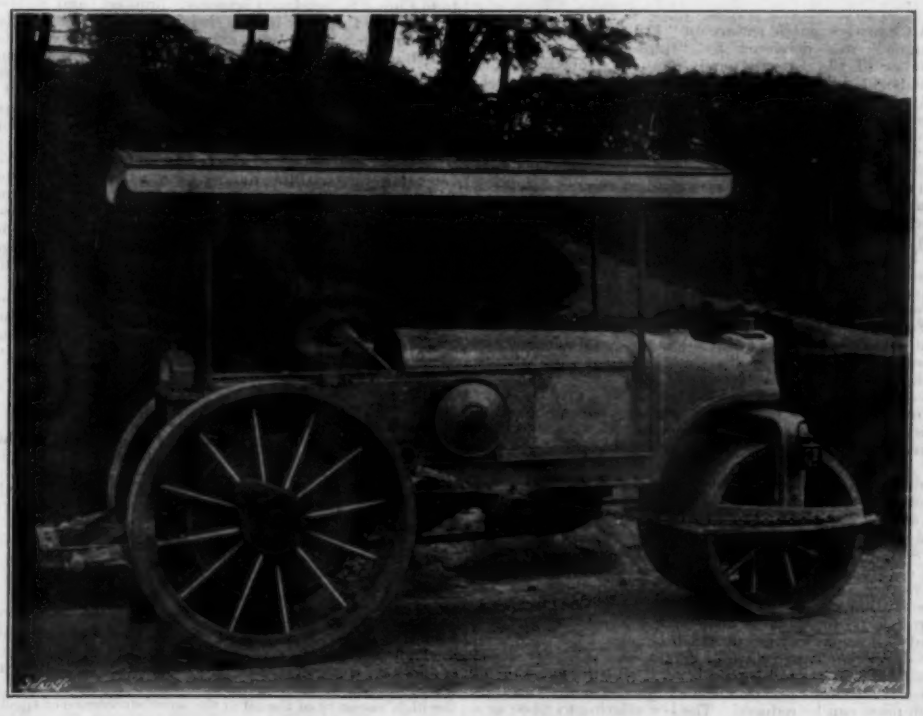


FIG. 5—RUSTON 8-TON 3-WHEEL MOTOR ROAD ROLLER

Locomotive Boiler Explosions.

As stated in our Railway Matters column last week, the coroner's inquest into the death of the two enginemen killed in the Buxton locomotive boiler explosion of the 11th inst. was adjourned until Wednesday, the 19th. It was resumed on the latter day, but after hearing evidence of identification and of the men through whose hands engine No. 134 had passed during the twenty-four hours before the explosion, the inquest was adjourned until after the Ministry of Transport inquiry. The latter was opened by Major Hall, assisted by Mr. Cramwell, of the Marine Department of the Board of Trade, on Tuesday last, but the proceedings were private.

According to the annual railway accident returns for the twenty years 1901–1920 inclusive, 99 cases of "the bursting of boilers or tubes of engines" occurred in that period, and resulted in 7 railway servants being killed and 111 injured. The returns do not distinguish between the explosions of boilers and the explosions of tubes, but as, with six exceptions, servants were injured, the consequences were apparently serious on each occasion. In the list of 99 explosions the Great Eastern was responsible 9 times; the Great Northern, 12; the Great Western 5; the Lancashire and Yorkshire, 13; the London and North-Western, 11; the London and South-Western, 4; the North-Eastern, 3; the South-Eastern and Chatham, 5; the Taff Vale, 3; and the Great Northern (of Ireland), 8. All the six fatal explosions, except one, in 1904, on the Taff Vale, were inquired into, and it may be of interest if we review the reports of the inspecting officers—then of the Board of Trade.

The Knottingley Explosion, 1901.

The most interesting of the five cases was that of a Lancashire and Yorkshire engine, the boiler of which exploded 2 miles 70 chains on the Goole side of Knottingley on March 11th, 1901. The interest lay in the fact that it was one of the late Mr. H. A. Hoy's big boilers, of which at that time there were forty, the first having been made in February, 1899. The engine was one of twenty big goods engines of the 0–8–0 class, and had been in use since the previous August 21st, having meanwhile run 15,007 miles. The engine, travelling tender first, was drawing fifty-two loaded coal wagons and a 20-ton brake, the total weight amounting to nearly 1000 tons. The train had been descending a gradient varying from 1 in 143 to 1 in 348 for 2618 yards, then on the level for 594 yards, and had travelled 858ft. on a rising gradient of 1 in 159, and was running at 20 miles per hour when the explosion occurred. The boiler was lifted completely off the frame, and thrown backwards and to the left side of the line, pitching in a field about 50 yards away. The engine was derailed on all wheels, and the framing bent outwards, more particularly towards the rear. The driver and fireman were killed.

A few months after this engine, No. 676, began running, leakages from the tube ends and side stays in the fire-box became frequent. One stay on the left side was renewed during the week ending December 15th, and another a fortnight later; in the week ending January 31st one on the right side was renewed. Three weeks later six stays on the right side and two on the left were renewed; five of these were cracked and three were broken. The six stays referred to formed a group and the plate was bulged. Notwithstanding the above repairs, reports by the drivers of leakages were most frequent, no less than twenty-nine entries, referring to leakages from the fire-box, having been made in the report book at

Goole between January 3rd and March 9th inclusive. Some of the leakages were described as "bad," others as "very bad." On January 28th a loaded train was left at Glasshoughton because the driver could not get sufficient steam to start the train owing to leakages in the fire-box, whilst on March 8th the loading of a train had to be reduced for the same reason.

Mr. Hoy, the then chief mechanical engineer, whilst making no definite statement at the Board of Trade inquiry, gave expression at the inquest to the opinion that the explosion was due to shortness of water. He admitted there was no evidence of overheating of the crown plate, except that the centre fusible plug was melted. Against the fact of the centre fusible plug being found melted, it is stated that neither of the other plugs were melted, and that the left one would have been much more bare of water than the centre one at the time of the explosion, and the inspecting officer said that it was due to the memory of the two enginemen that it should be said that there was no evidence to show that the explosion was because of any want of care or attention on their part. The conclusion of the inquiry was that the material of the fire-box stays—an alloy of copper 62 lb., zinc 38 lb., iron 6 oz.—was unsuitable, and that though its tensile strength was high when cold, yet it became weak at the temperature that it was exposed to in the side of a fire-box. The report concluded with the observation that the hydraulic test of 220 lb. was unusually low, and should be considerably increased.

The Oaks Explosion, 1906.

On April 9th, 1906, there was an explosion in a fire-box on a 2–4–2 tank engine on the Lancashire and Yorkshire near The Oaks Station. A large bulge, measuring 3ft. 2in. in length, 2ft. 8in. in width, and 5in. in depth, was formed in the crown of the fire-box, owing to the failure, through overheating, of a group of sixty stays. The overheating was due to an accumulation of loose scale on the fire-box crown, which had been inadvertently or carelessly overlooked when the boiler was cleaned and washed out five days before. The driver was injured on this occasion, but there was no material damage except to the boiler.

The Wath Explosion, 1907.

A fatal explosion occurred on September 25th, 1907, in the fire-box of a 0–6–2 tank engine at Wath, on the Hull and Barnsley Railway. The driver was killed, but the fireman was away from the engine at the time, so was uninjured. The engine was derailed, and the whole of the left-hand side of the fire-box was blown completely out and carried a distance of 40 yards. The explosion was caused by the failure of a group of stays, about thirty in number, situated near the bottom of the left side of the fire-box in the second, third, fourth and fifth rows, counting from the bottom, the attachment of which to the copper plate had become defective. The clenched heads of these stays were completely wasted away, and this part of the fire-box side was, in consequence, dependent for support on the screwed parts of the stays in the stay holes, but owing to the repeated hammering and caulking of the ends to make them steam-tight, the threads had been seriously damaged, and the stays had become too short, the ends being below the fire surface of the plate. In this condition they were unable to support the plate, and the latter was forced over the end in the form of a bulge.

The engine was constructed in 1901, and thoroughly overhauled in 1905. It underwent several repairs after that, and it is important to note that on March 23rd, 1907, the load on the safety valve was reduced by the shed foreman from 170 lb. to 160 lb. per square inch, owing to the condition of the fire-box. The engine continued to work without proper repairs being made to the boiler, and on several occasions the drivers found a difficulty in maintaining sufficient steam to haul the full load, and the train in readiness when the explosion occurred had had to be limited to twenty loaded wagons instead of twenty-six. A boilersmith examined the boiler on the day before the explosion, and although he stated that he did not think the fire-box was in a dangerous condition, he verbally reported to the shed foreman that it was time the engine went into the shop for a proper overhaul, owing to the condition of the stays in the fire-box. In consequence of this report, the shed foreman arranged that the engine should be sent into the shop as soon as another, then being overhauled, was ready to take its place. It was mainly due, said the late Colonel von Donop in his report, to an error of judgment on the foreman's part in allowing the engine to continue at work, that the explosion must be attributed.

The Cardiff Docks Explosion.

An explosion of no little interest occurred on April 21st, 1909, at Cardiff Docks, Rhymney Railway. The engine was a 0–6–2 saddle tank. The entire fire-box crown was torn and blown out in one piece, and the boiler was wrenched from the frame and thrown about 45 yards. The evidence given was very voluminous, but it appears that on the day before the explosion a waste of steam was noticed, and the foreman mechanic at the shed gave instructions which led to the joint under the lower part of the safety valves being re-made. This work necessitated the removal of the safety valve chest bodily from its place, but owing to the boiler feed tank being situated over the boiler, the safety valve lever had to be first disconnected before the chest could be lifted off. This, again, necessitated the removal of the nuts on the upper eye-piece by means of which the tension in the spring was regulated. No measurements were taken of the amount the spring was extended at the proper adjustment, and no notes were taken as to how the washers were placed. To cause the valves to lift at 145 lb., at which pressure they had always previously lifted, would require the insertion of a washer, ¼in. thick, under the lever, so as to limit the extension of the spring to about ¾in. The fitter, however, placed the washer above the lever, which would load the valves to 185 lb. The changing of the washer had even a more disastrous effect. The safety limits inside the spring had apparently only ¼in. bare clearance and would become locked by the increased extension of the spring. The effect was to render the valves immovable; no steam could escape, and the pressure in the boiler accumulated much beyond that shown on the gauge. The driver, about 11 min. after he had left the shed, tried the injectors, but could not get them to work. This, of course, was due to the pressure in the boiler exceeding the maximum pressure, 220 lb., for which they were designed. The engine was therefore taken back to the shed and had been put over a pit to drop the fire when the explosion occurred, killing three servants and injuring three.

The Tunbridge Wells Explosion.

On April 29th, 1912, as a train of empty carriages was travelling between Tonbridge and Tunbridge Wells on the South-Eastern and Chatham Railway, the fire-box roof collapsed. The driver and fireman were driven or blown off the foot-plate and seriously injured. The engine was of the 4–4–0 type, running tender first, on a rising gradient varying from 1 in 53 to 1 in 100. The cause of the explosion was a serious shortage of water. The top of the fire-box had become overheated, the stay ends and nuts were thus weakened to such a degree that a large number of them failed to withstand the ordinary working load. The overheated part was plainly visible over the whole area of the crown, and extended down the sides of the fire-box along an even line some 4in. below the top, just below the upper row of side stays, which were sagged, they also having been overheated. Mr. Carlton, who acted as assessor to Colonel Pringle, was satisfied that for some time before the explosion took place the fireman mistook empty gauge glasses for full ones.

NOISE.

A Chadwick public lecture on "Problems of Noise and Fatigue" was delivered by Professor Spooner, C.E., member of the International Committee on Industrial Fatigue, at the Public Hall, Blackburn, on November 21st.

After some introductory remarks explaining how he was led to take an interest in the general question of industrial fatigue, and particularly of that aspect of it that embraces the fatiguing effects of noise, the lecturer stated that a period spent in the midst of working machines and mechanical operations, causing deafening and strident sounds of a wide range, with shocks to the auditory nerves, produces a feeling of sensory fatigue; and that although this fatigue attacks primarily a single organ, it, little by little, extends to the whole nervous system, leading in some cases to such a feeling of weariness that it may impair the capacity for work in a greater degree than severe muscular fatigue.

For some trades the noise is so great and continuous that before the workers reach the age of forty they become more or less deaf; boilermakers, riveters and trunk makers in particular, suffer in this way, whilst few people have normal hearing if they have lived in a great city for many years, as the traffic has become almost unbearably noisy. He explained what science has done to assist the hearing of such sufferers, and how, by the use of suitable ear stoppers and antiphones, the ear may be protected against the effects of violent noises. He then proceeded to classify the primary kinds of noise calling for attention in all our activities, but particularly in our factories, and discussed the expedients which have been and can be employed to reduce, eliminate or prevent such noises. He explained the use of vibrometers for the detection of vibrations in high-speed machinery, and dwelt on the great value of rubber in solving many noise problems, particularly for flooring, the treads of stairs, and for roads—the construction of which has not kept pace with the development of vehicular traffic—in cases that would justify its use. He also dealt with the transmission of noise from shops and rooms to adjacent ones, and how such noise can be reduced. The law relating to noise as a nuisance, both private and public, was touched on, and Professor Spooner concluded by appealing to his audience to observe America's annual "Fatigue Elimination Day," on December 5th, the first Monday in December. That movement against human waste due to avoidable fatigue, initiated by Gilbreth in America many years ago, and by the lecturer in this country in 1917, meant that each one of us was called upon to consider seriously at odd moments during Fatigue Day what could be done to reduce or eliminate avoidable fatigue, and this year it had been decided to concentrate attention on avoidable noise, and by so doing to help in the suppression of its tyranny. There should be, Professor Spooner declared, a standard limit of permissible noise, which, to exceed, would be a legal offence.

DEVELOPMENT OF THE PORT OF ORAN.

The British Vice-Consul at Oran has reported to the Department of Overseas Trade the proposals put forward by the local Chamber of Commerce at its general meeting held on October 4th, for certain works to be undertaken for the extension of the port of Oran. It may be explained that the whole of the quays and warehouses of the port are the property of the local Chamber of Commerce, which has practically constructed the port and quays at its own expense by loans authorised by the French Government, and with certain allowances supplied by that Government on behalf of the Colony of Algeria.

The present programme is elaborate, and will need considerable time and a large amount of money before it is realised. No details are provided by the Chamber of Commerce as to the precise dates the various undertakings are to be commenced—some were started before the war, and on that account were abandoned—but all are mentioned as of urgent necessity. It may be generally taken that the present Chamber of Commerce is determined to do its utmost to further the development of the port and commercial output of the town and its province, and is continually urging both the Government and municipal authorities to undertake improvements in conjunction with itself.

The proposals mentioned by the Vice-Consul number thirty-three, and, generally speaking, include the extension of the port eastwards, so that that portion will consist of five large modern basins. Added to this, is the Mers el Kebir harbour, situated immediately to the west of Oran, where improvements under an old scheme will be completed and new plans evolved to make the whole a combined port large enough to meet the needs of the province and town—incidentally, one of the largest in the Mediterranean. The scheme involves many important subsidiary works, such as the development of inland communications with the port by the construction of new railways, sorting stations and roads, and the alteration of those means already existing; the provision of adequate lighting, policing and fire-preventive apparatus in the port; of modern machinery for facilitating the loading and discharging of ships; of a fresh water supply for ships; of adequate warehouse accommodation and a free-pass Customs House warehouse for goods in transit for Morocco. The proposals mention the establishment of a commercial exchange, a commercial club and library; of a commercial educational scheme, and the embellishment and extension of the residential part of the town and suburbs, and generally envisage a recreated town in accordance with the most modern ideas.

SHIPBUILDING IN HONG KONG.

In the early part of September last the vessels in course of construction in the local dockyards at Hong Kong—the Hong Kong and Whampoa, Taikoo and Bailey's—represented some 44,750 tons of merchant shipping. On the stocks in the yards of the Hong Kong and Whampoa Dock Company there were at that time about 26,000 tons under construction, the vessels comprising four oil tankers for the Anglo-Saxon Petroleum Company, a boat for the Indo-China Steamship Company, Limited, and a steel twin-screwed steamer for the river trade of a gross tonnage of 4400 tons, which was expected would be ready for launching some time during last month. The vessels being constructed by the Hong Kong and Whampoa Dock Company for the Anglo-Saxon Petroleum Company were of a gross tonnage of 5600 tons, and are of the Inherwood type. They were the Paludina, Petricola, Planorbis and Pleiodon, and are sister tankers.

The Taikoo dockyard was constructing a vessel of 7500 tons for the Blue Funnel Line, which will be fitted with a geared turbine engine. The total tonnage in hand in this dockyard is 17,432, the total not including two towboats for the Blue Funnel Line, as they are under 100 tons register. Three steamers for the China Navigation Company were on the slips, while a fourth was at the fitting-out wharf. The steamer Kwang Chow, which is of 2500 tons, was nearing completion. The steamer Kwangtung, a steel screw vessel of 2500 tons, was launched on August 24th, while another steamer of the same tonnage as the Kwangtung was being completed for the China Navigation Company at the Taikoo dockyard.

The Bailey yard had in hand four lighters with an aggregate tonnage of 1327 tons, together with a number of smaller vessels, launches and lighters. There was a twin-screw motor ship being built for a Manila firm, while the lighters were for the Standard Oil Company. They are to be named the Delaware (600 tons) and the Brooklyn (360 tons). There was also under construction in the Bailey yard a twin-screw lighter of 200 tons for the Government of Java.

In the course of a paper on "The Elimination of Oil-field Waste," delivered before the Institution of Petroleum Technologists, Mr. A. Beeby Thompson said that quasi-emulsions—that is, merely mixtures of oil and water which separate by long standing—are generally due to the high viscosity of the oil or the small difference of specific gravity of the oil and water. Their separation can be accelerated by application of heat. Separation of oil and water mixtures can be accomplished by a centrifuge, but true emulsions do not readily admit of such easy handling. Success has attended the use of centrifuges with a rate of revolution of 15,000 to 16,000 per minute. The electrical process has so far proved most satisfactory for breaking down refractory emulsions. Oil is a non-conductor of electricity, and if a high-tension current is allowed to pass through an emulsion it follows the direction of the water globules, and in the process breaks up the mixture and causes the pellicles to coalesce. If the emulsion is previously warmed, rapid separation follows, provided short-circuiting is prevented by keeping the liquid in motion.

Railway Matters.

ANSWERING a question, Mr. Neal stated on November 10th that the railway returns for 1920 were in the hands of the printer, and it was hoped to issue them before the end of the month. They have now been published.

THE "Sunny South" special of the London and North-Western and London, Brighton and South Coast companies is to be restored on Thursday, December 1st. This is one of the earliest cross-country trains, and provides through communication between Liverpool, Manchester and Birmingham and Brighton and Eastbourne *vid* Willesden.

BEING reminded that the increase in railway rates made in September, 1920, was for the avowed purpose of securing sixteen months' revenue in eleven months, Mr. Neal, on the 10th instant, explained that depression in trade and the coal stoppage largely defeated this aim and rendered any general reduction in rates before the end of Government possession impracticable.

IT may be recalled that Mr. Wilson-Fox, whose death has just been announced, was chairman of the Select Committee of 1918 which inquired into the subject of transport within the United Kingdom. It made a very valuable report, and some interesting recommendations, but the establishment, the following year, of the Ministry of Transport prevented anything being done.

AT the general meeting of the South Indian Railway Company on the 9th instant, Sir Henry Kimber, the chairman, said that, generally, the recommendations contained in the report of the Acworth Committee were of a far-reaching character. Those recommendations had not, however, been communicated officially to the railways, and no action was called for until they were.

THE deepening of the inner harbour at Holyhead, the property of the London and North-Western Railway Company, which is desirable in order to accelerate the transit of the Irish mails, was sanctioned by a late Bill last August. The contract for the work has now been let to the Tilbury Contracting and Dredging Company, Westminster. In addition to ordinary dredging there are nearly 200,000 tons of rock to be removed.

Now that fuel is reduced in price and there have been reductions under the sliding scale in wages, the Transport Sub-committee of the Association of British Chambers of Commerce is anxious for a reduction in railway rates, and the railway companies are to be asked to receive a deputation on the subject. We have reason to believe that the companies quite appreciate the position, and will make reductions in certain directions as soon as they can see their way to do so.

THE Secretary of State for India told the House of Commons on the 8th instant that he was not yet in a position to make a statement as to the policy arising out of the recommendations of the Acworth Committee. He had asked the Government of India for its general views on the report, and it would be necessary to take the opinion of the Indian Legislature. He did not think it would be reasonable to impose any definite time limit for consideration, but he had been, and was now, in constant telegraphic communication with the Government of India on the more urgent matters reported on by the Committee with a view to action as soon as possible.

SPEAKING at the meeting, on the 17th instant, of the shareholders of the Lancashire and Yorkshire Railway, which was to approve the scheme for the amalgamation of that company with the London and North-Western, the chairman said that if the scheme were approved it was proposed that the amalgamation should have effect as from January 1st next. Provision would be made for the Lancashire and Yorkshire board to remain in office for the purpose of preparing the accounts and balance sheet and declaring the dividend for the present year. In the event of the sanction of the Amalgamation Tribunal set up by the Railways Act not being given to the scheme until after January 1st, the board would continue to manage the undertaking in the ordinary way up to the date the sanction was received.

THE report of Major Hall on a collision on September 9th at Newcastle, North-Eastern Railway, shows how inquiries are held into even minor accidents when such accidents suggest irregular or inefficient methods of working. A train left No. 6 bay line for Middlesbrough, and it was followed by the light engine which had brought the train into the bay line. Three consecutive signals were duly lowered for the passenger train, but the fourth—the up advanced starting signal—was at "danger," and the train pulled up. The driver of the light engine was apparently not prepared for this action, and he let his engine collide with the passenger train. The inquiry revealed one weakness in operation, viz., that whilst the light engine and other engines similarly following trains out of bay lines get the platform starting signal "repeated" for them, *i.e.*, put to "danger" behind the train and then again lowered, the two signals outside the station are not "repeated." Further, the light engines have to follow the trains for half a mile and into the next block section, and yet are not block-signalled forward.

A MATTER of great importance was laid before Mr. Arthur Neal, of the Ministry of Transport, on the 9th instant. A deputation from the locomotive, carriage and wagon industries expressed the anxieties of those engaged in the production of locomotives and railway rolling stock at possible results of the provisions of Sec. 16 of the Railways Act. We presume Sub-section (2) (*b*) was referred to. It says that the Minister of Transport may require or authorise two or more companies "to adopt schemes for the co-operative working or common user of rolling stock, workshops, manufactories, plant and other facilities." The deputation urged that the Ministry, in the exercise of its powers, should see that private enterprise had equal opportunity of competing for railway supplies with the railway groups themselves. Mr. Neal pointed out that as grouping could not be completed until 1924, there was ample time to consider the extent to which that particular part of the Railways Act would affect the industries represented. Without pledging himself further, he promised to give the fullest consideration to any representations, whether from bodies of employers or workpeople;

Notes and Memoranda.

IT is reported from Aalesund, in Norway, that a Mr. Mittet has invented a machine which spins thread from both ends, and which is expected to revolutionise the textile industry. The thread produced is said to be much stronger than that made by the present method, and the machine works seven times as fast as ordinary machines.

IN order to increase the seating capacity of the Central Presbyterian Church, Buffalo, New York, which is a stone structure, the front was cut away from the rest of the building, set on rollers and moved a distance of 30ft. with the aid of screwjacks. That portion of the structure moved was 78ft. wide, 65ft. high and 8ft. thick. The actual time required to move the front of the structure was sixteen hours.

WRITING in the *Iron and Coal Trades Review*, on some notable borings for prospecting coalfields, Mr. A. E. Ritchie says that the early borers in Kent experienced much difficulty in passing through the gault, which swells when wet and is the cause of frequent stoppages owing to the jamming of the tools. The Germans, however, by using petroleum instead of water for flushing the boreholes, found no difficulty in getting through this stratum.

EXPERIMENTS are being made by the Staveley Coal and Iron Company, Limited, with the distillation of waste shale from the mines. The retort is shaped like an ordinary tobacco pipe, a return to the original form, and induced draught is used. The yield of crude oil, stated to be paraffin, is given as 30 to 40 gallons per ton. For comparison it can be taken that the Scotch oil shales yield 18 to 45 gallons per ton, but this industry is largely dependent on the production of ammonium sulphate, which is at the rate of 35 lb. to 70 lb. per ton.

MANY of the tunnels on the Southern Pacific Railway are lined with timber, and numerous fires have occurred in the tunnels; but, strangely enough, there is nevertheless no record of fire being started by a locomotive, even in the coal-burning days, and the oil-burning engines now used are less hazardous. The causes to be guarded against are outside sources, train wrecks, and human carelessness. For the first, it is well to clear the ground of brush, trees, grass and weeds for 100ft. beyond the entrance, and to whitewash the timbering annually for 50ft. from the portal.

IN concluding a paper on the "Work of the Industrial Fatigue Research Board, read before the Royal Society of Arts, Mr. D. R. Wilson said: "My experience has convinced me that the work of the Board has had an indirect effect which is, perhaps, not less important than its contributions to knowledge. In each of our industrial investigations we have received the help of employers and workmen nominated by the trade concerned. They have met on new and common ground, and it has been very striking to notice the mutual goodwill and the real interest taken in our work throughout by both alike. One reason for this, I suggest, is that industrial life is being viewed from a special angle, whereby employers and workmen get a new insight into one another's difficulties. For this reason alone, the continuance and expansion of the work that we have begun would, I am convinced, be of great value."

IN the latest official report on the commercial conditions of New Zealand there are the following notes on the hydro-electric developments of the islands. The three main sources selected for the North Island are at Mangahao 24,000 horse-power, Arapuni 96,000 horse-power, capable of extension to 162,000 horse-power, and at Waikaremoana 40,000 horse-power, capable of extension to 136,000 horse-power. Constructive work is now well in hand at Mangahao, and it is estimated that the installation should become available in 1923. Work has been started also at Waikaremoana, but owing to doubts having been expressed as to the efficiency of the foundations for the proposed Arapuni dam, the northern part of the scheme is, for the time, delayed. With regard to the South Island, the system will include the existing power station at Lake Coleridge, the Dunedin City Council's plant at Waipori Falls and the proposed Southland Electric Power Board's scheme at Lake Monowai.

AN unusual type of explosion, which occurred in a Hull oil mill, is described as follows in the official report by the Board of Trade:—The introduction of water with the oil into the still during the process of oil distillation, resulted in a rapid rise of pressure due to the formation of steam, and also caused frothing of the fluid contents in the still. The safety valve lifted to relieve the unusual pressure which was formed, and the discharge of frothy oil and inflammable vapour became ignited, and the fire which was thus started surrounded the still. The openings in the apparatus were not of sufficient area to cope with the rising pressure, and the still, weakened by overheating, therefore burst. The case indicates the necessity for adequate arrangements for settling water out of oil which is to be subject to such distilling processes, and also for so arranging the openings from relief valves on such stills, that discharge therefrom, always of an inflammable nature, shall be led away to a safe place, and preferably kept in closed circuit.

IN the course of an article in the *Drop Forger*, Mr. H. A. Whiteley says that burning apparently occurs by the steel becoming fused at the crystal boundaries and combining with oxygen, forming "lakes" of oxide. These are easily observable under the microscope and have a characteristic globular shape. If examined in the "as stamped" condition, burnt patches are associated with a very coarse overheated structure, and the oxide occurs in the ferrite areas usually along crystal boundaries. Such a steel will be weak mechanically and consequently dangerous in use. The oxide, like slag, cannot possibly be eliminated by any form of heat treatment (short of re-melting), although the surrounding overheated structure may be refined. Many claims for processes for restoring burnt steel have been put forward, but, as far as is at present known, only neutralise the effect to a greater or less extent by breaking up and distributing the oxide into smaller patches. Once formed in a steel, no matter how distributed, burnt patches are, at least, a potential source of trouble, and forgings containing them should be scrapped immediately.

Miscellanea.

ACCORDING to reports from Petrograd, the Allmaenna Svenska Elektriska Aktiebolaget has been granted a concession to build electricity works at Yaroslav, on the Upper Volga.

ACCORDING to a Berlin report, the German Government has protested against the Allied intention to disable the Hindenburg Bridge over the Rhine at Bingen, considering it a military expedient. The Germans advance the motive that the bridge is an important junction between the Rhine banks and has an economical character.

THE discovery of rich silver ore on the Kitsault River district of Vancouver, on claims close to the famous Dolly Varden mine, has been reported. Three general samples taken free from native silver average more than 100 oz. to the ton, and the body of ore of this richness is said to be very extensive. It has an average width of 22in. and adjoins lower-grade ore, which carries good milling values.

THE chairman of the Manchester Gas Committee (Alderman W. Kay) recently expressed the opinion that there was every possibility of the price of gas supplied by the Corporation being lowered in the near future. On December 31st the Committee will take over the supply of the Stretford and Urmston areas, and arrangements have been made for improving the supply in these areas, especially to the new houses.

THE Chief Inspector of Factories has published, through the Stationery Office, an illustrated chart (Form 932), describing the symptoms of carbon monoxide poisoning, giving hints as to first aid and diagrams showing the Schäfer method of producing artificial breathing with the aid of an oxygen apparatus. A memorandum (Form 827) on carbon monoxide poisoning has also been published setting out more in detail the dangers due to this gas and the necessary precautions.

AN International Conference of Electrical Engineers opened in Paris on the 21st inst. under the auspices of the International Electro-technical Commission. The Conference was presided over by M. Le Trocquer, Minister of Public Works, and was attended by forty delegates from twelve countries. The object of the Conference is to study the construction and installation of high-power transport systems connecting up high-power transmission stations. Thursday's sitting was held at the Sorbonne, and was presided over by M. Millerand, the President of the Republic.

ALTHOUGH there are now signs of a revival in the steel industry in France, it is not expected that it will be so marked before the end of the year as to bring this year's total output up to the figure for 1920. There were eighty-two blast-furnaces in operation on July 1st last year, ninety-one on January 1st, 1921, and only seventy-two on July 1st this year. The greatest steel output for France is registered by Alsace and Lorraine, with 746,076 tons, which is equivalent to 41 per cent. of the total steel production of the country. The furnaces in Eastern France provide 626,638 tons, or 34 per cent.

IN his presidential address to the South Staffordshire Mining Students' Association at Walsall, Dr. J. S. Haldane said that an occupation like coal mining could not be carried on successfully without not only individual skill, but also work co-ordinated in endless different ways to secure both safety and economic efficiency. The British coal-mining industry could never have been built up but for high ideals of mutual loyalty on the part of the men engaged in it. These ideals were present in all, from pony drivers to general managers, and it seemed to him there was nothing Great Britain had more reason to be proud of than her coal-mining industry.

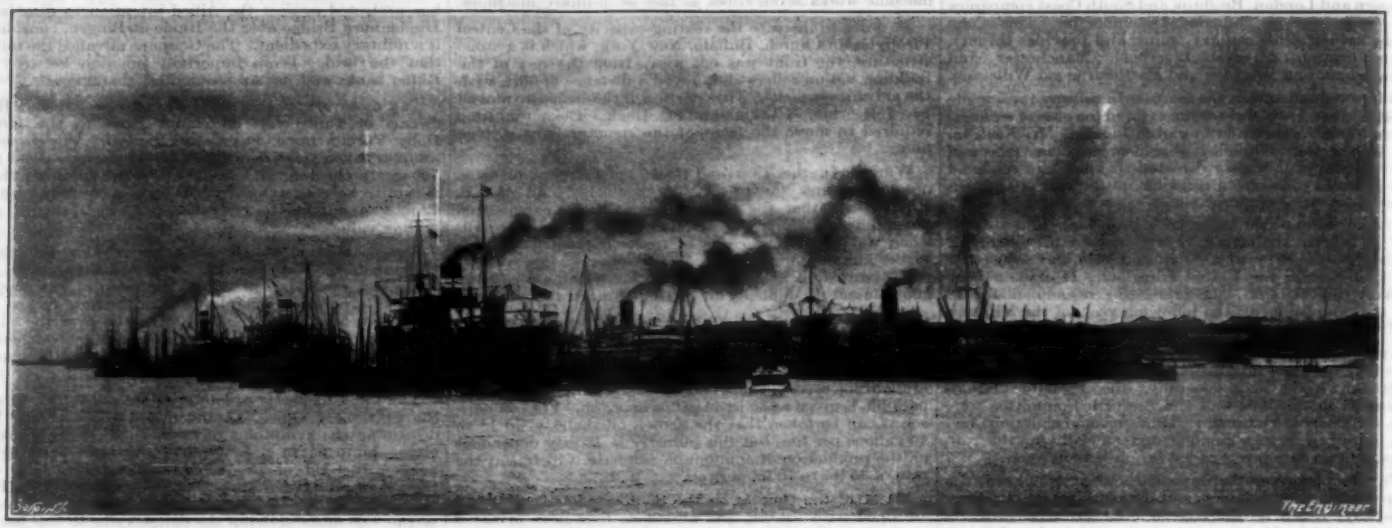
THE Crompton Medal, awarded annually by the Institution of Automobile Engineers for the best paper read during the session has been awarded to Mr. H. L. Heathcote for his paper on "Ball Bearings." The prize annually awarded by the Council of the Institution for the best paper read before any of the Graduates' Centres was awarded to Mr. E. L. Bass, of the London Centre for his paper on "Lubrication," and the second prize was awarded to Messrs. E. Chatterton and L. F. Watson for their paper on "Factors affecting Power Output." The premium placed at the disposal of the Council by the Daimler Company has not yet been awarded, but the competing papers are of such a high standard that the paper which receives the award will be read before the main Institution at one of the London meetings.

AT the instance of the Chinese Ministries of Foreign Affairs and Agriculture and Commerce, the National Bureau of Water Improvement is making preparations for the formation of a Commission, which will consist of:—(1) Representatives from the Ministries of the Interior, Foreign Affairs, Communications, Finance, Agriculture and Commerce, and the National Bureau of Water Improvement. (2) Representatives from the administrative bodies of the Yangtze provinces. (3) Representatives from the Provincial Assemblies of the Yangtze provinces. (4) Representatives from Chambers of Commerce of the Yangtze Provinces. (5) Experts on hydraulic engineering and water improvement. The Commission will also discuss such questions as the betterment of the river communication of the Yangtze, especially between Hankow and Wuhu.

THE Board of Control for Apprenticeship Training in Bengal has drawn up a scheme of apprenticeship training which, it is hoped, will greatly improve mechanical engineering education in Bengal. The scheme, which will be put into operation at Kancharapara immediately, consists of an admission examination (similar to the graduate examination of the Institution of Mechanical Engineers), followed by four years' training in workshops with compulsory attendance at a technical school to be built at Kancharapara. All the apprentices will live in barracks to be provided by the railway. It is hoped that by the end of the four years of training the brighter students will have reached such a standard of proficiency in mechanical engineering subjects as will enable them to proceed to a two years' course in the mechanical engineering department of the Bengal Engineering College.

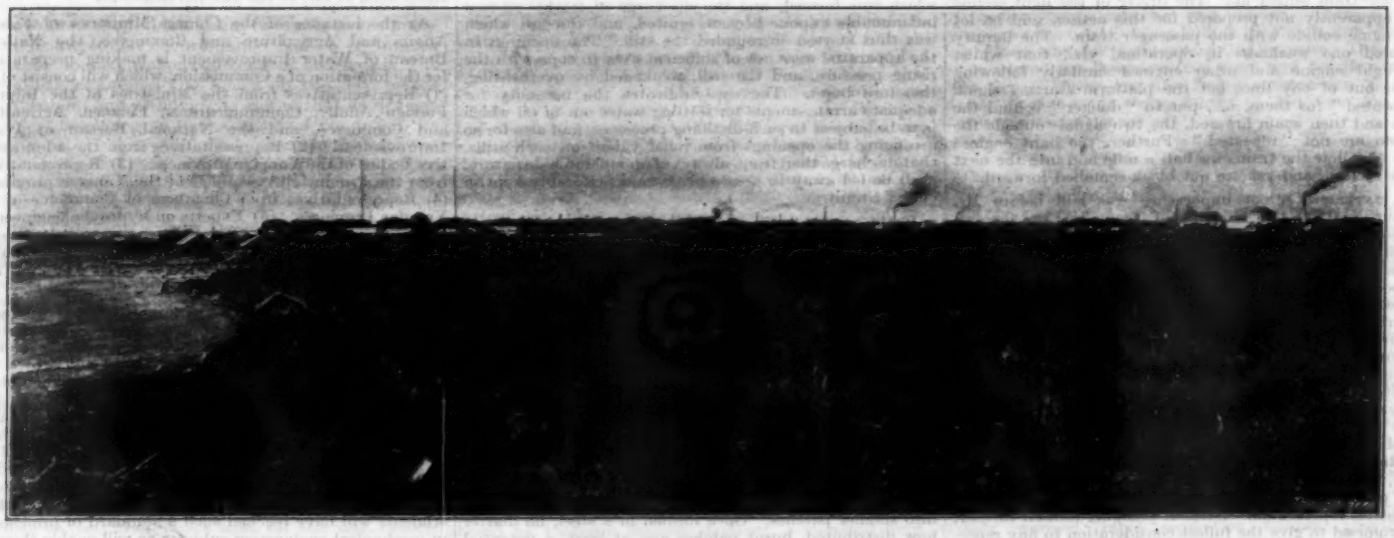
RANGOON AND ITS PROPOSED NEW Ddocks

(For description see page 560)



SHIPS LOADING RICE AT FIXED MOORINGS IN THE RIVER

SHIPS ALONGSIDE THE WHARVES IN THE HARBOUR



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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

*** *With this week's number are issued as a Supplement two pages of engravings illustrating some Notable Vessels of the Japanese Navy. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

*** *If any Subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

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NOVEMBER 25, 1921.

Reflections on Naval Disarmament.

The suspension of work on the four British ships is the most important development which has occurred since the American plan was announced to the world. It was, we believe wholly unexpected. Few people imagined that a pious avowal would so rapidly be translated into a fact, and there is still much perplexity as to the reason which inspired the hasty action of the Government. It is considered unlikely that the proposals will be accepted without modification. Amidst all the enthusiasm which they have evoked it is well to remember that they were drawn up by American statesmen and American naval officers, who were doubtless guided as much by considerations of national interest as by motives of pure altruism. That being so, it would be absurd to pretend that we in this country have no right to criticise or question a single item in the programme. It is not only our right, but our manifest duty to scrutinise with particular care a plan which aims at determining British naval policy over a long period of years, for the Navy is still the Empire's first line of defence, and sea power—in whatever sense the phrase may be interpreted—remains, as it has ever been, the cardinal condition of the Empire's existence. If, therefore, it were found on closer investigation that any part of the plan was incompatible with the maintenance of an adequate measure of sea power, it would be the duty of those representing the British Empire to suggest the necessary modifications. In these circumstances we cannot but feel that it would have been wiser to continue work upon the ships if for no other reason than that the orders for material would have reduced unemployment.

There is little reason to suppose that drastic amendment will be necessary. The limits of capital ship strength appear to be fair and reasonable to all three parties, with the possible exception of Japan, and it is mainly in regard to the proposed allotment of cruiser and submarine tonnage that grounds for criticism exist. Assuming that cruisers are necessary for the protection of sea-borne commerce—and nothing in the experience of the late war justifies the contrary view—then it is obvious that the British Empire, with its unprecedented volume of ocean trade and its dependence on the safety of the marine highways, could legitimately lay claim to a larger proportion of such vessels than is needed either by America or Japan. It remains to be seen whether the American naval authorities are willing to concede this claim, which in our judgment must be firmly upheld. In the opening stages of the late war we were seriously hampered by the dearth of fast cruisers, and had the enemy displayed more enterprise and boldness he might have made us pay heavily for our neglect to provide a sufficient number of high-speed cruising ships. Since we have no guarantee that in a future war our commerce would be immune from the attentions of surface raiders, like the Emden and the Karlsruhe, the risk must be minimised by keeping the cruiser establishment at the standard of strength recommended by our naval advisers. It seems to us neither prudent nor feasible for this country to surrender the right to take such precautions as may be deemed requisite for the protection of its floating commerce, considering the vital part which that factor plays in the national existence. Exception has also been taken to the submarine proposals, but for very different reasons. In this case the British view is not that America offers too little, but that she offers too much. It is a fact that the suggested figure of 90,000 tons as the limit of displacement for the British submarine flotilla is greatly in excess of our present establishment, so that in this type of vessel it would be a case not of "scrapping," but of new construction, if we wished to attain the prescribed standard of strength. We infer from their very liberal allowance of tonnage that American naval experts set a high value upon the submarine, and in this they are doubtless right. It is a formidable weapon both for defence and offence, but as the nation which suffered most from its employment in the latter capacity, Great Britain regards it, not without reason, primarily as an instrument of offence, and one to which she is peculiarly vulnerable. No secret is made of the fact that our Government would welcome the total elimination of the submarine. If that were agreed to it would be considered, in this country at least, by far the greatest achievement of the Washington Conference. We fear, however, that the submarine will not be got rid of so easily. When tentative proposals for its abolition were put forward at the Peace Conference they met with such uncompromising opposition from several quarters that they were not pressed. It was pointed out that the British objection to the submarine was not wholly disinterested, that it was essentially the weapon of the weaker maritime Powers, and that its disappearance would simply confirm the supremacy of the Dreadnought, which only the richest States could afford to build. But although these arguments would not be difficult to refute, the real point is that since American naval opinion is partial to the submarine, it would be useless to discuss the question of abolition. Nor, as we observed last week, would much practical value result were a limit to be set to the dimensions of future submarines. It would be possible, without exceeding a very modest displacement, to endow a submarine boat with a cruising radius that would enable it to act as a commerce destroyer on the high seas. The radius of a submarine is largely determined by the physical and moral qualities of its crew. There were many instances in the late war of boats considerably smaller than 1000 tons undertaking ocean voyages up to 7000 sea miles, a performance that would have been thought incredible before the war.

If we fail to secure at Washington a substantial reduction of the amount of submarine tonnage originally proposed in the American scheme, and if, at the same time, the Conference leaves its participants a free hand in respect of submarine dimensions, the next few years will assuredly witness the intensive development of this type of craft. The United States has just begun work on two fleet submarines which are said to have a surface displacement of approximately 2000 tons and a sea endurance of 10,000 miles. Japan is credibly reported to be building even larger boats, which are to be of exceptionally high speed, judging from the power of their Diesel engines, which have been ordered from a well-known firm in Europe. And on November 1st the keel was laid at Chatham Dockyard of what is described as the largest submarine ever designed for the British Navy. To these facts must now be added the authoritative report that two of the American battle-cruisers, whose construction as such will be arrested under the limitation scheme, will be completed as aircraft carriers, each with a speed of 33 knots and accommodation for 100 bombing, torpedo and fighting planes. It would appear, therefore, that if American naval opinion is somewhat doubtful as to the possibility of maintaining perpetual peace on the seas, it is fairly confident that in any future naval campaign submarines and aircraft will play the leading *rôles*.

American Telephone Work.

Whilst from time to time many engineers have visited America and other parts, with a view to studying various branches of engineering practice, comparatively few have placed the results of their visits on record. Last week, however, Mr. E. S. Byng, of the Western Electric Company, read a paper before the Institution of Electrical Engineers on "Telephone Line Work in the United States," and showed with the aid of an excellent collection of lantern

slides, which he obtained during a trip to America, the manner in which many operations in connection with this work are carried out. One important, though perhaps not unexpected, fact which the author brought to light was that telephone lines are erected in America much more rapidly than they are here. Labour-saving contrivances, such as excavating machines for trench work, pole-hole excavators, concrete mixers, and pole erecting trucks, are, it seems, utilised extensively. Very elaborate arrangements are also made for training the men, who, when fully qualified, are paid at high rates. With the aid of special devices, which the author described, the ordinary jointers are said to be able to joint as many as 100 "pairs" an hour on a subscribers' cable, whilst the more experienced men can deal with as many as 150 "pairs" per hour. Similarly, in respect to the erection of poles, the speed of working is extraordinary. On country roads where the poles have been laid out along the route in advance and where the holes have been excavated, it is possible, it is said, to erect under favourable conditions 25ft. poles at the rate of about forty per hour, and the maximum number erected in an eight-hour day by one foreman and eight men using a 3-ton erecting truck being 300.

It is perhaps scarcely necessary to remark, in view of the character of the paper, that there was very little discussion of an important character. Judging by the questions that were asked, few of the members present seemed very familiar with American telephone practice, and as the author had only approximately three minutes in which to reply, and was compelled to confine himself almost exclusively to the remarks of a single speaker, the discussion, if it may be described as such, was not particularly instructive. A certain amount of opinion was, it is true, expressed in respect of the use of glass insulators, but on this point the speakers were not unanimous. One member argued that in this country the climate was altogether unsuitable for such insulators, whilst another thought that this conclusion was possibly erroneous, and in view of the fact that glass insulators had been used successfully in France, the matter called for careful consideration. It was also pointed out that more ought to be done in the way of constructing underground subways for telephone and lighting cables, &c., as sooner or later some of the London streets would become so congested with underground pipes, &c., that it would be impossible to put a pick in the ground without hitting something. By far the most severe criticism of the evening came from Sir William Noble, the Chief Engineer to the Post Office, who, speaking towards the close of the meeting, expressed doubts as to the possibility of erecting poles and making joints at the rate specified by the author. He hoped that what Mr. Byng had told them was true, but it seemed very much like a Yankee story. If the Post Office could find a firm that could erect poles at the rate of 300 in eight hours it would be pleased to hand over the job. Sir William also referred to the remarks of a previous speaker, who had said that although many visitors came from the Colonies and other parts to inspect telephone work in this country, British engineers seldom paid similar visits abroad. The reason, Sir William contended, was that such visits were unnecessary. This opinion will not, we think, be shared by all who are engaged in telephone work. The methods adopted by the Post Office telephone engineers may be good, but it is surely wrong to assume that nothing is to be gained by keeping in touch with what is being done elsewhere. From the subscribers' point of view, at any rate, the London telephone system is not always faultless! It is, of course, perfectly well recognised that in many ways American conditions differ widely from those that prevail here. The possibility of getting workmen in this country to erect poles and make joints at the rates specified is, as Mr. Byng admitted in the course of his reply, very remote, although there appears to be no doubt that the speeds mentioned are attained under practical conditions in the United States. Special efforts were, it seems, made by the author of the paper to confirm all the figures supplied by actually witnessing the work being carried out. Efforts on the part of the author to speed up operations here do not, however, seem to have resulted in the American rate of working being approached. Apart altogether from the difference in temperament of the English and American worker, there is also a marked difference in the rate of pay, which in the latter case corresponds in English money to about 6s. per hour. The ready acceptance of machinery and labour-saving devices by American workmen has been conducive to high efficiency. Trade unionism exists to some extent, but there is no desire to hamper output. The men are said to accept any suggestion for speeding up the work, as they believe that it is to their advantage to reduce cost, and it has been possible, in consequence, to place the majority of the telephone workmen on the staff of the various companies instead of employing them on an hourly basis.

There is a great deal in Mr. Byng's paper which might be dealt with, but sufficient has been said to indicate the general lines upon which it is written. Many will, of course, argue that work carried out at high speed cannot be satisfactory. Here, again, however, we have the author's assurance that such is not the case, as the increased speed is due in no small measure to the use of special mechanical and labour-saving devices. Having regard to the magnitude of the American telephone system and the very thorough study which Mr. Byng appears to have made of it, we have little doubt that his paper will, in spite of any opinion that may exist to the contrary prove of some assistance to those who are looking for methods which will enable telephone work to be carried out expeditiously. That all the schemes described are applicable to this country we do not for a moment believe, but, taken as a whole, the paper can scarcely fail to arouse interest in telephone circles both in this country and abroad.

Naval Armaments and the Washington Conference.

No. II.*

(By a Correspondent.)

A RETROSPECTIVE survey of the shipbuilding statistics of Great Britain for the last thirty years reveals the fact that prosperity in the steel, iron, and associated trades has always been coincident with a large naval programme. It is useless now to consider whether this undoubted condition was due to the Government orders for ships acting as a fly-wheel to trade in that particular industry or to the confidence created by the knowledge that a strong man armed keepeth his goods in peace—always provided he is sufficiently strong—or if other influences combined assisted in producing this result; but, taking generally the periods of affluence and depression, it is indisputable that in shipbuilding and marine engineering, with their wide ramifications among sub-contractors, trade did undoubtedly follow the flag. Taking, for instance, the cycle of good years, 1891–2, 1896–7, 1903–4, 1909–10, and allowing for the hiatus, 1914–18, and the bad years, 1919–21, it was reasonably certain that 1922–3 would see a considerable revival from the appalling depression of the previous twenty months, during which we have witnessed a state of affairs for which no parallel exists unless we revert to the decade subsequent to the Battle of Waterloo. The number of orders for ships placed in Great Britain during 1921 has been exceptionally small; it is confined practically entirely to the four big battleships just ordered and now suspended, and many large firms have not secured a single contract for over a year. It is true that several large merchant ship programmes are in hand, though some are partially suspended; but all of them were arranged in 1919–20, and to-day, with the exception of a very few foreign orders, there is very little work immediately in view. In these circumstances, the question of the cancellation of the new ships and the simultaneous acceptance of the American suggestion for a ten-year naval holiday may well be received with very mixed feelings.

The very clearly defined proposal of the United States Government for a reduction of naval armaments is remarkable both for its obvious honesty of purpose and for the manner in which it provides a basis for adjustment between the naval Powers of the moment. Nor can it be suggested that the United States are not offering to make much larger immediate sacrifices than they suggest that others should do. In considering the general excellence of the omelette we have always been warned not to consider the lamentable fate of the eggs, but there can be no doubt that, welcome as the proposed scheme must be towards reduction of unnecessary international expenditure, there are various interests that are bound to be temporarily affected to no uncertain extent. Very little careful consideration of Mr. Hughes' speech and Mr. Balfour's reply is necessary before it is clearly seen that this consequence has been taken into account, and the realisation of the disturbance to the individual is entirely subordinated to the good of the world in general. With great boldness, the United States have offered to scrap all of the battleships and battle-cruisers of their 1916 programme, with the exception of the just-completed Maryland. Of these, the three other ships of the "Maryland" class have all been launched this year and are in a state of completion of about 60 to 80 per cent. Of the newer twelve vessels of 43,000 tons odd, the six battleships have reached a state of about 38 per cent. completion, and the six battle-cruisers average about 16 per cent. completion. With unemployment already at a distressingly high figure in the United States and with their shipbuilding industry in a precarious position, the future gain to that country by the sacrifice of over 600,000 tons of naval construction work must be valued at no small amount when they are willing to make such a remarkable sacrifice as this. Great Britain is asked not to proceed with four vessels for which even the working designs are far from commencement and for which little work has already been actually undertaken, and that only on the armament and not on ships or machinery. Japan is asked to scrap some 200,000 tons of work in hand, one vessel of which is launched, and to forego the commencement of another 90,000 tons which is authorised. These proposals in principle have been accepted by the British and Japanese delegates, and it is presumed that the four British ships will be indefinitely postponed. In view of the fact that the American proposal, if accepted, limits the size of future units to 35,000 tons, we may never be privileged to see the completion of these very remarkable designs. For the future, the general principle of limitation of the three present largest navies to a certain tonnage has already been accepted, and the figures apparently decided on for capital ship tonnage are 500,000 each for Britain and the United States and 300,000 tons for Japan. For cruisers—exclusive of battle-cruisers, which are contained in the previous total—auxiliary craft, and torpedo craft the suggested figures for the three Powers have been respectively 450,000 each and 270,000 tons. The questions of replacement, period of life, &c., together with the proportion which auxiliary craft should bear to the total capital ship tonnage have been referred to a Naval Committee, and until a report is issued on the subject the precise extent of the reduction and the influence on future orders will not be known.

These figures of tonnage, as we suggested in our issue of October 28th, affect Great Britain to a far greater extent than either of the other Powers, and while there need be no disposition to cavil at the suggested balance of power, it may well be asked whether, in the light of experience, the amount available for Great Britain will be sufficient for a world-wide Empire. Considering the disposition of the Colonies and Dominions and the distances which separate them from England, our view unhesitatingly is that the proportions suggested for auxiliary craft are either far too small for the British Empire or else excessive for the other countries, and this peculiarly wide distribution of British territory was obviously to the forefront of Mr. Balfour's mind when he replied to Mr. Hughes' speech. Taking tonnage as a basis for comparison and using the figures for vessels built and building in the various categories of first, second, and third-class vessels as published in Brassey's "Naval Annual," which is probably the most accessible volume for general reference, and without undue detail, the quantities in the possession of the various Powers during the last twenty years can be fairly accurately gauged from the following table. No

Comparative Table of Total Tonnage Built and Building at Various Periods.

Year.	Type of ship.	Japan.	United States.	France.	Great Britain.
1901	Battleships:				
	1st class ..	84,700	202,000	160,000	530,000
	2nd and 3rd cl.	—	—	170,000	205,000
	Cruisers:				
	1st class	58,200	141,500	180,000	443,000
	2nd and 3rd cl.	—	—	—	391,000
1911	Battleships:				
	1st class	184,500	254,000	255,000	938,000
	2nd and 3rd cl.	48,000	100,000	101,000	212,000
	Cruisers:				
	1st class	138,000	187,000	169,000	630,000
	2nd and 3rd cl.	67,000	69,000	145,600	321,000
1921	Capital ships* ..	576,920	1,088,600	210,750	701,000
	Light cruisers† ..	60,850	82,250	53,700	360,000
Suggested 1922–5	Capital ships ..	299,700	500,650	—	604,450

* This line corresponds to the tonnage of the vessels given in the table on page 442 *ante*.
† Only modern vessels included.

torpedo craft, fleet repair ships, or unarmed auxiliaries figure in this list, yet in 1901 we had some 40,000 tons of 27 and 30-knot craft, and to-day, even with all the post-war scrapping of destroyers, we have probably some 250,000 tons of large new craft available. It is in the cruiser and auxiliary totals that we foresee some shortage if very strict adherence to displacements rather than to a consideration of numbers be observed. Thus in 1901 we had forty-three first-class cruisers built and building, and no less than 106 second and third-class. The scrapping of older vessels by Sir John Fisher about 1905 reduced these figures somewhat, but in 1911 we had forty-two first-class and seventy-four second-class vessels. The 1921 figure is too much affected by war conditions to be strictly comparable; we have sixty-nine vessels of 360,000 tons, including all between the "Town" class and the Hawkins, whereas the other three countries have thirty-seven of 196,800 between them, and the French total consists largely of surrendered German ships. The suggestion that we should retain 90,000 tons of submarines is perhaps unnecessary. Probably no one would regret their entire suppression.

With the exception of expressing a doubt as to

* No. I. appeared October 28th.

whether the quota of auxiliary tonnage allowed to Great Britain will be adequate for the bare needs of the Empire, for the amount of steaming to destinations alone is a very formidable item, the American scheme is open to little criticism; its palpable honesty of intention, as evidenced by the sacrifices the Americans propose to make themselves, has excited universal admiration; but we were hardly prepared for the sudden cessation of all work on the four British ships. In the present state of British shipbuilding the cancellation of even two of the four big ships will involve no small sacrifice to contractors throughout the country. A sum of probably ten million pounds would have been expended on those four during the next twelve months, and though until perhaps next March there would have been no appreciable influence on the unemployment question, during the remainder of next year these vessels would have been invaluable in this respect. At the present juncture, when it is all-important to get the steel works back into working order, the orders for material which these vessels represent would have gone a very long way towards filling the inevitable gap which must occur before mercantile building can possibly revive. It must be remembered that an overwhelming majority of suspended commercial work is already well advanced as far as steel construction is concerned. There is relatively little tonnage remaining on the stocks and there are very few other orders to take the place of it.

The position of the armament firms particularly is a delicate one. The armour-producing capacity of the country, for instance, to-day is colossal; the five firms manufacturing it possess plants out of all proportion to future needs; but presumably the risk of lack of employment has been amply covered in the prices charged for armour plate during the Dreadnought era. A good deal of Japanese armour plate for vessels in hand is being made in Sheffield, and this, apparently, will not now be required. Even a future 35,000-ton ship will not require more than 9000 to 10,000 tons, which is probably only about a sixth of our annual capacity. A large proportion of the heavy gun manufacturing plant in the country is comparatively new, and unless it was heavily written off in the recent settlements between the firms and the Government, seems likely to remain an unwieldy charge against its owners unless it can be transferred to some national plant such as Woolwich, which, it is anticipated, will probably construct all naval armaments for some time to come under the proposed scheme of limitations. Compared, however, with the reductions in primary expenditure and on their annual upkeep—for these new ships may each be estimated to cost about £750,000 a year—the depreciation of armament manufacturing plant in the country is in reality a small item, though large in absolute amount to the individual firms affected. Quite apart from these very specialised plants, a large number of small firms which have developed largely on their contracts with the Admiralty will be proportionately affected. The necessity, however, of keeping large private armament works employed has in the past led to a very distinct incitement to build and to not a little construction of quite unnecessary foreign tonnage. The national value of these great plants was clearly shown in recent years; it cannot, however, be maintained that a wholesale reduction in their production was not anticipated by all concerned.

It is on the officers and men of the Royal Navy that the limitation in armaments will for some years press so hardly. After the Napoleonic campaign only about one-fifth of the number of ships-of-the-line and frigates were retained in commission; all the rest of the war fleet was paid off. Two years ago very sweeping reductions in *personnel* were made and a further cut of very large extent is inevitable. The Portsmouth and Devonport dockyards will, it is widely anticipated, do most of the replacement work in future. The question of employment of dockyard hands in commercial works has always been fraught with difficulty owing largely to the differences between their trade limitations and those of trade union members in the North; but the sweeping reduction of future tonnage cannot fail to affect the dockyard towns. The limit of 35,000 tons in future will obviate the necessity for a very great expenditure on new dry docks. Just as one hundred years ago, the reduction of the Royal Navy was effected on a huge scale, so unfortunately does the proposed limitation seem likely to carry with it similar consequences, and it is in some of these that technical progress may be adversely affected just as it remained very stationary during the first half of the nineteenth century.

The successful prevention of war, however, is an achievement of such outstanding magnitude that these detail disadvantages to the individual, unpleasant as they must be for a short period, offer no obstruction whatever to the development of the scheme in principle. One of the likely defects of wholesale reduction in naval expenditure is apt to prove to be the loss to science as a whole which the keen competition in armaments has so enormously advanced. The Royal Navy was one of the great experimental establishments in the world, and much of the work done in such directions as development of wireless telegraphy, compass manufacture, improvements in metals, form of ships or nautical surveying has been tremendously extended as the result of Admiralty research. Any limitation which is likely to cramp the continual search for improvement which the pressure of naval opinion has always insisted on will be a far worse effect than the temporary unemployment which a naval holiday involves. Complete cessation of construction for ten years has serious disadvantages in convenience. The disorganisation of staffs and plant undoubtedly leads to difficulty in suddenly preparing for war; but it would seem to be far better to confine armament construction to Government yards working continuously at a slow rate of output than to cease entirely and then begin afresh.

As regards other nations, all the interruption to trade that will be experienced in Great Britain will apply with equal or even more force to the United States. The reduction in taxation due to the lapsed programmes will be of greater benefit, probably, to Japan than to any other nation. France and Italy are but little affected; naval construction in both countries has been virtually stopped for some years, and capital ship tonnage amounts to but 200,000 in the former case and 105,000 in the latter. If reference be made to the table of capital ship tonnage published in our issue of October 28th, it will be seen that the American proposals contemplate the entire suppression of all vessels laid down since 1917 and the scrapping of a few laid down prior to 1909. The finished vessels which we are invited to remove from this list are the four "Orions," the Lion and the Princess Royal as well. Sentiment as well as common sense may affect the details of the Naval Committee's report, and the Lion may be retained, as also the Mutsu, which, as she is launched, the Japanese seem anxious to retain. Quite a number of the existing British light cruisers of the "Town" and "Arethusa" classes are becoming obsolete, and the torpedo craft flotillas consisting, of about 210 British and some 260 United States vessels, contain a large proportion that would in any case have shortly found their way to the shipbreakers. The actual destruction of existing tonnage proposed is not great, although the "Orions" are still useful ships. What the American scheme does excel in is the prevention of the colossal and really quite unnecessary proposed programmes. The new Japanese Navy Law covering the years 1922–6 envisages at least six more capital ships, and the United States 1922–4 programme contemplates four more monster battleships. Mr. Hughes was right when he said that "the time had come, not for general resolutions for mutual advice, but for action." What reply Britain would have made to these coming programmes can only be imagined. There was one week—we believe it was early in 1903—when no less than eight first-class battleships and cruisers were put into the water from British yards. Displacements of 15,000 and 10,000 tons respectively were the vogue at that period, but competition on the 45,000-ton scale in a war-sick world is an unjustifiable absurdity.

The remarkable display of common sense which seems to have characterised the proceedings at Washington may be taken as a clear indication that there will be a reasonable amount of latitude granted to each nation, partly to soften the shock of suppression of existing programmes and partly in the question of replacements in order to obviate too severe a disorganisation of districts affected by the future retrenchments. Much as one must sympathise with those who suffer directly from the present effects of the agreement to cease building more than a limited quantity of naval ships—and it is sad to reflect that battleship construction represents perhaps the highest development of the science of naval architecture—the subsequent benefit to the world at large must far outweigh all questions of this nature. Long before we lay down our first 35,000-ton "standard" battleship the action of the United States Government in putting an end to extravagant competition will probably have been appreciated by all with the gratitude which it deserves.

BOOKS RECEIVED.

Thermodynamics. By J. E. Emswiler. London: McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 18s. net.

Introduction to Physics for Technical Students. By P. J. Haler and A. H. Stuart. London: The Library Press, Limited, 26, Portugal-street, W.C. 2. Price 4s. 6d. net.

Gasoline and Other Motor Fuels. By Carleton Ellis and J. V. Meigs. London: Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 2. Price 60s. net.

Dock and Lock Machinery: A Technical Manual. By W. H. Hunter. London: Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 2. Price 17s. net.

Automatic Telephone Systems: Volume I., Circuits and Apparatus as Used in the Public Services. By William Aitken. London: Benn Bros., Limited, 8, Bouverie-street, E.C. 4.

Blue Printing and Modern Plan Copying for the Engineer and Architect, the Draughtsman and the Print Room Operative. By B. J. Hall. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 6s. net.

British Labour Replacement and Conciliation, 1914–1921. Being the result of conferences and investigations by Committees of Section F of the British Association. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

The Public Works Conference.

No. I.

In conjunction with the Congress on Public Works, Roads and Transport, which has been held daily during the past week at the Agricultural Hall, a series of conferences had also been arranged. Each day's conference was held under the direction of a different Institution, although the whole was under the general supervision of the Institution of Municipal and County Engineers. On the first day, Friday, November 18th, the proceedings actually began at a luncheon which was held at the Holborn Restaurant, under the chairmanship of Sir Henry Maybury. Thereafter there was a meeting stage-managed by the Institution of Gas Engineers, at which several papers dealing with the part which the gasworks plays in public works were read. Mr. T. Hardie, President of the Institution of Gas Engineers, presided at both morning and afternoon sessions.

The first paper was presented by Dr. J. S. C. Thomas and Mr. Dean Chandler, of the distribution department of the South Metropolitan Gas Company, and it was entitled "Public Lighting by Gas." A considerable amount of information was given of the manner in which this company has dealt with public lighting installations, and at the same time indicated briefly some of the history of this very controversial subject. The merits of gas *versus* electric lighting, for the purpose, however, were not entered into. It was urged that street lighting should be based, so far as light sources are concerned, on a specification of the candle-power to be provided and the essential characteristics of their polar distribution curves. It is pointed out that the matter of public lighting, as indeed of all matters of gas supply, has been considerably simplified by the passing of the Gas Regulation Act of 1920, under which gas authorities specify the quality of the gas they intend to supply. This brings within the region of possibility the standardising of apparatus which sets the matter of public lighting upon an exact quantitative basis. Hitherto half-hearted attempts have been made to cope with the changes in the composition and properties of town's gas employed in public lighting by the provision of devices for the adjustment of the hourly rate of consumption by the burner and of the air induced thereby. Long experience, however, has, the authors explained, shown that burners without gas or air adjustments which will give an efficiency deviating little from a pre-ascertained value, can be designed, provided that the calorific value of the gas does not depart from the declared value by more than plus or minus 25 B.Th.U.

One of the chief points brought out in the discussion was the need for uniformity of lighting of the great arterial roads, instances being quoted of accidents being caused through vehicles passing from a well-lighted to a badly lighted road, according to the ideas of the local authority concerned.

The second paper was on "The Utility of Benzole for Transport Purposes," by Captain E. de Normanville. The author put forward the now well-known advantages of benzole for motor work. As he pointed out, the great difficulty at the moment is to obtain sufficient supplies, and although he held out the prospect of a production of 50,000,000 or 55,000,000 gallons per annum, the present figure was, he stated, far short of that, while the price was higher than that of petrol. Better supplies were anticipated when the coke ovens get more busy and gasworks find it an economical process to strip their gas more completely than they do at present. As has so often been said, from the gasworks point of view it is a question of the consumer of gas having to pay more in order to provide benzole for the motorist, because gas oil has to be added to the stripped gas to make good the deficiency, and at present it is not economical to do that except at the expense of the gas consumer.

One of the best papers of the day was that by Mr. H. W. James, manager of the tar works of the South Metropolitan Gas Company, on "Coal Tar for Road Work." In it he criticised the two specifications for tar for road work which are most used, viz., that of the Ministry of Transport and that of the B.E.S.A. The latter, he said, went farther than the former, inasmuch as it attempted to define the word "bitumen." The result was most unfortunate and was nothing more nor less than the perversion of a well-known term as regards its application in a particular industry. The principle that had been adopted was that those particular types of bituminous binding agents which were, in the view of the Committee, best suited for road work should alone be classed as bitumen in the future. This attitude was, the author maintained, quite unjustifiable, and it was, he added, very much to be deplored. One could hardly imagine scientists accepting such a definition, based as it was on the use of the material in one industry alone. If it was generally accepted that a committee might lay it down that only those bitumens considered by it best for its work should be called bitumen, a precedent was thereby set up which might justify the members of any industry in similarly imposing a nomenclature based on their requirements. It would be quite in order for the block fuel manufacturer to exclude from his definition of bitumen everything but the varieties of pitch that satisfied him; the user

of bituminous coal could adopt a definition of coal that would throw out all non-bituminous types, and the instrumental musician, who has too often but little sympathy with the vocal art, might even frame his definition of music in such a manner as entirely to exclude the latter. This was admittedly carrying the argument to its extreme, but it served, said Mr. James, to show that if it be granted that any body of men might handle a generic term in such a way that they could apply it just to those particular classes of the genus that they fancy, the result would be endless confusion. Bitumen was considered by that great geologist, Sir Charles Lyell, to be typified by the black substance that oozed from Newcastle coal when it burned. Coal tar chemists would probably mutually agree in regarding their pitch as consisting of bitumen plus free carbon (or insoluble matter). If the sub-committee's definition of bitumen was generally approved, and was to apply in future only to substances that occurred in the natural state, or as residues from the treatment of asphaltic oils, what new word were we to invent that would take its place as a generic term, and include coal tar and the several other forms of bitumen? The bitumens had already been classified according to their origin, and if the Committee chose to say that those bitumens that were found in the natural state or obtained as a residue from asphaltic petroleum were, in its opinion, to be grouped separately as regards their value for road work, on account of their possessing certain properties, their action would at least be logical. But it was surely inadvisable, urged Mr. James, that, in order to avoid confusion in the selection of bituminous material, a deliberate confusion should be made, and made quite unnecessarily, in the use of the term "bitumen."

Generally, the paper was a plea that there should be greater co-operation between highway engineers and tar distillers with a view to suggesting broad lines along which specifications might be based, taking as a foundation absence of water and the grading of tar according to consistency.

Mr. W. J. A. Butterfield, in the discussion, suggested that there should be separate specifications for tars produced in different parts of the country, because tar produced in the West of Scotland contained 12 per cent. free carbon and was far more viscous than the tar produced in London, which contained 20 per cent. free carbon.

Mr. F. E. Bristowe complained that highway engineers could not agree upon the standard of efficiency of the tar they required. Mr. W. G. Adams, a tar distiller, pointed out that the American specifications went farther than the British, and allowed 25 per cent. free carbon, and something like 80 million gallons were used annually on the roads.

The final paper for the day was by Dr. J. S. Owens, who showed by figures and diagrams how the impurities in the atmosphere, particularly of London and Glasgow, had been reduced with an increase in gas-consuming appliances during the period 1914–21.

On Saturday, November 19th, the meeting was under the auspices of the Institute of Cleansing Superintendents. The only paper read was that by Mr. W. J. Heavey, superintendent of cleansing to the City of London, who propounded "An Economical Scheme for Dealing with London's Refuse." The author pointed out that there are at present twenty-nine local authorities doing this work, with consequent overlapping and waste. Without going into details, he said that he had prepared a scheme for dealing with London as one unit, and that a firm of contractors whose *bona fides* no one could doubt was willing to take on the work upon terms which would mean a total saving of £250,000 per annum over the present cost. Full details were promised if the London boroughs thought sufficiently well of the idea to call a special conference to consider it.

There was a lively discussion in which speaker after speaker strongly denounced the suggestion that this work should be given out to contractors. Indeed, not one speaker supported the proposal to work through a contractor, although all were agreed that it is a matter which should be taken in hand and dealt with on some comprehensive lines. Mr. Heavey, in his reply, said he was not enamoured of contractors, but in this case it would save a large capital expenditure on plant and at the same time save the present authorities many thousands of pounds in each individual case. If they did not care to consider it further there was an end of the matter.

The Society of Chemical Industry.

SYNTHETIC AMMONIA.

A JOINT meeting of the Chemical Engineering Group of the Society of Chemical Industry with the Institution of Mechanical Engineers was held on November 22nd in the hall of the Institution of Electrical Engineers to discuss a paper on "The Claude Synthetic Ammonia Process and Plant," by Mr. J. H. West. Mr. J. Arthur Reavell took the chair, and was supported by Captain Riall Sankey, the President of the Institution of Mechanical Engineers.

Mr. West read his paper at some length, and illustrated many of his remarks by means of lantern slides. He commenced by comparing the Claude process with the older Haber process, and pointed out that the chief difference between them lies in the much higher pressures used by Claude. Both depend upon the direct combination of hydrogen and nitrogen in the presence of a catalyst, a reaction which has, of course, been understood for some time. It is necessary in order to make the two gases combine that they should be subjected to considerable pressure, and the Haber apparatus works at about 200 atmospheres, at which pressure about 13 per cent. of the gases combine to form ammonia. Claude, however, appreciated that by increasing the pressure a much larger proportion of the gases could be made to combine, and that the size of the plant for a given output could be correspondingly reduced. He thus uses a pressure of some 900 atmospheres, or nearly 6 tons per square inch, and secures the combination of 42 per cent. of the gases. The result is that the overall dimensions of a Claude plant are quite insignificant as compared with those of a Haber plant, and one of the slides which were projected on the screen showed how a complete Claude factory could have been erected in one of the hydrogen gasholders at the Oppau works, where the Haber process was employed before the recent terrible explosion.

When working at the comparatively low pressure adopted by Haber, it is necessary to supply a certain amount of external heat to keep the reaction going, but at 900 atmospheres the combination of the gases goes on so vigorously that the necessary temperature is maintained automatically. The most useful range of working temperature has been found to lie between 500 deg. and 700 deg. Cent. It will be readily appreciated that the construction of vessels to withstand these pressures and temperatures has been no easy matter. A Haber catalyst vessel capable of producing 20 tons of ammonia a day stands over 42ft. high, and is 3ft. 9in. in diameter, with walls about 7in. thick. The weight is 74½ tons. The shell is made of high tensile, probably tungsten, steel, and is protected inside by a lining of pure iron. As the iron is permeable to hydrogen the outer vessel is perforated all over with small holes, so that any hydrogen passing through the lining may escape without setting up a pressure between the lining and the outer vessel.

A Claude plant to produce the same amount of ammonia as that just mentioned would require sixteen catalyst tubes, but each of them would only weigh 14 cwt., so that the total weight would be about 11½ tons. Each tube would measure 7ft. in length by about 9½in. diameter and 4in. bore. The material of which they are made is a special alloy, devised by the Vickers company, known as Vicronic. The tubes are cast solid and are bored out. The head, or plug, is secured by an interrupted screw, like that used in the breech of a gun, and is tightened against a copper washer by means of hand-operated screw gear. Inside the tube there is a casing of thin sheet iron, for holding the catalyst material. This casing is fixed to the head, so that it is a simple matter to remove it, for renewing the catalyst, whenever that is necessary.

Before being put in service the tubes are tested by fixing them in a closed vessel and subjecting them to an internal pressure of 10 tons per square inch. The outer vessel is filled with water and is equipped with a stand-pipe, or burette. The rise of the water in the burette indicates very delicately the extent to which the tube stretches. Mr. West mentioned, in connection with these tests, that at a pressure of 10 tons per square inch water compresses by about 6 per cent., and he said that the stretching of the tubes did not, by any means, follow Hooke's law. A faulty tube was quickly revealed by the rise of the water in the burette, and ample warning was given before failure took place.

In order to attain the high pressures required by the process the gases are compressed in two stages, first to 100 atmospheres, and then to 900. It is noteworthy in this connection that the second stage only absorbs about one-half the horse-power required in the first stage, as the power varies as the logarithm of the pressure difference, and log 100 = 2, while log 1000 = 3. The fallacy of the laws of Boyle and Charles is exposed when working at these high pressures, and the lecturer showed that in the case of hydrogen it only required 570, instead of the theoretical 1000, volumes to fill unit space when compressed to 1000 atmospheres, while with nitrogen the amount was even less, below 500 volumes. According to Charles' law a volume of hydrogen measuring 1000 at 0 deg. Cent. and 900 atmospheres pressure should become, on heating to 200 deg. Cent., 1733 volumes, but as a matter of fact it really only expanded to 1449 volumes.

The packings used in the super-compressors are plain cup leathers, and in order to prevent them from getting overheated they are water-cooled. Mr. West exhibited some leathers which had been in service, and there certainly was no indication that they had ever been so hot as to lose their flexibility.

In a part of the plant which is used for extracting hydrogen from coke-oven gas there is an engine that does useful work in expanding the gas down from a pressure of 25 atmospheres. The temperature is thus reduced to about − 215 deg. Cent. The problem of lubricating this engine proved a difficult matter, and even petroleum ether, which freezes at − 90 deg. Cent., was found to be useless. The difficulty was overcome by mixing a little nitrogen with the hydrogen. The nitrogen liquefies in the cylinders and forms a lubricant.

The whole process of manufacturing ammonia was described in the paper, but as it is of more immediate interest to chemists than to engineers we have confined ourselves in these notes rather to the problems which appeal to the latter.

In opening the discussion Captain Riall Sankey said that he should have expected operation at pressures so high as 900 atmospheres to present a very difficult problem; but it appeared that that was not really the case, and, in fact, M. Claude had actually been enabled to simplify his apparatus by the adoption of high pressures. The law which governed the matter seemed to be that the higher the pressure the more simple the apparatus, so he wondered what would be the effect of going up to 2000 atmospheres pressure. He asked if, in view of the apparent divergence from Hooke's law discovered in testing the Claude tubes, any experiments had been made by releasing and re-applying the pressure in the tubes. The subject under discussion emphasised, he considered, the value of co-operation between the various branches of science. There were so few Admirable Crichtons in this world that the capabilities of tackling both the engineering and the chemical aspects of a problem were seldom found in one man.

Dr. Harker urged that proper justice was not generally done to English chemists in connection with synthetic ammonia, and that while the pioneer work was generally attributed to Haber, he was, as a matter of fact, very largely helped by Drs. Rossignol and Greenwood. The high pressures adopted by Claude were not the only means by which the synthetic process could be improved, and Dr. Harker said that just as good results as Claude's had been obtained at the University College by Dr. Greenwood, but by an entirely different process. Dr. Harker asked if the percentage combinations of hydrogen and nitrogen mentioned by Mr. West were working values or the equilibrium values as understood by chemists, and inquired as to the relative performance of the several catalytic vessels used by Claude.

Mr. William Reavell said that he presumed the author was considering isothermal compression when he said that the super-compressor only used half the power of the primary compressor, but expected that the greater mechanical losses and leakage would increase the power required by the super-compressor to some extent. He asked if the values given by the author for the compressibility of hydrogen and nitrogen referred to compression at constant temperature, and how the observations were made. The author had described petroleum ether and liquid nitrogen as being lubricants, but Mr. Reavell suggested that they acted rather as moistening agents in keeping the leathers soft. It was generally agreed that the lighter the oil the less its viscosity was increased by reduction of temperature, so he could not quite understand how such liquids could have "unguentious" properties at the low temperatures under consideration.

Mr. W. H. Patchell commented on the apparent boldness of the inventor in conveying gases, at the high pressures he used, from one part of a building to another by means of jointed pipes, and hinted that the copper rings used in the joints were wider than those he would have used for the purpose. Mr. Patchell asked the author if he could give any information as to the action on steel of hydrogen at high pressures.

In replying to the discussion, Mr. West said that the experiments on the strength of the Claude tubes had been extended as suggested by Captain Sankey, and that the strain followed a straight line law, on the second application of the load, from the point at which the last test had been stopped. He did not think that the mechanical losses in the super-compressor were much greater than those of the primary compressor, and as to leaks, they only amounted to about 0.5 per cent. Any serious leakage was very quickly discovered on account of the fog which it produced.

A vote of thanks, which was heartily accorded, was proposed by Professor Hinchley.

THE LATE SIR DOUGLAS FOX.—In an obituary notice of the late Sir Douglas Fox, which appeared in our issue of the 18th inst., by a slip of the pen we stated that it was the late Sir James Mirrlees with whom Sir Douglas was associated in connection with the Mersey Railway. We should, of course, have said "the late Sir James Brunlees." We are asked to state that Sir Douglas' firm will be carried on under the title of Sir Douglas Fox and Partners by the following remaining partners:—Mr. Francis Douglas Fox—son of Sir Douglas—Mr. Ralph Freeman and Mr. Bertram D. Fox.

THE TRAINING OF ARCHITECTS.—The Royal Institute of British Architects has published a pamphlet containing full particulars of the channels through which membership of the R.I.B.A. may be gained, together with a list of the "recognised schools," and the special exemptions which have been granted to candidates who take certain of their courses. The pamphlet gives information concerning the three stages which a candidate has normally to pass to obtain the associateship R.I.B.A. He must qualify as a probationer, as a student, as an associate, and full particulars are given as to the qualifications required for registration as a probationer, as to the intermediate examination, success in which qualifies a probationer for registration as a student, and as to the final examinations which qualify for registration as associate. The pamphlet may be obtained at the R.I.B.A., 9, Conduit-street, W. 1, at the price of 1s. exclusive of postage.

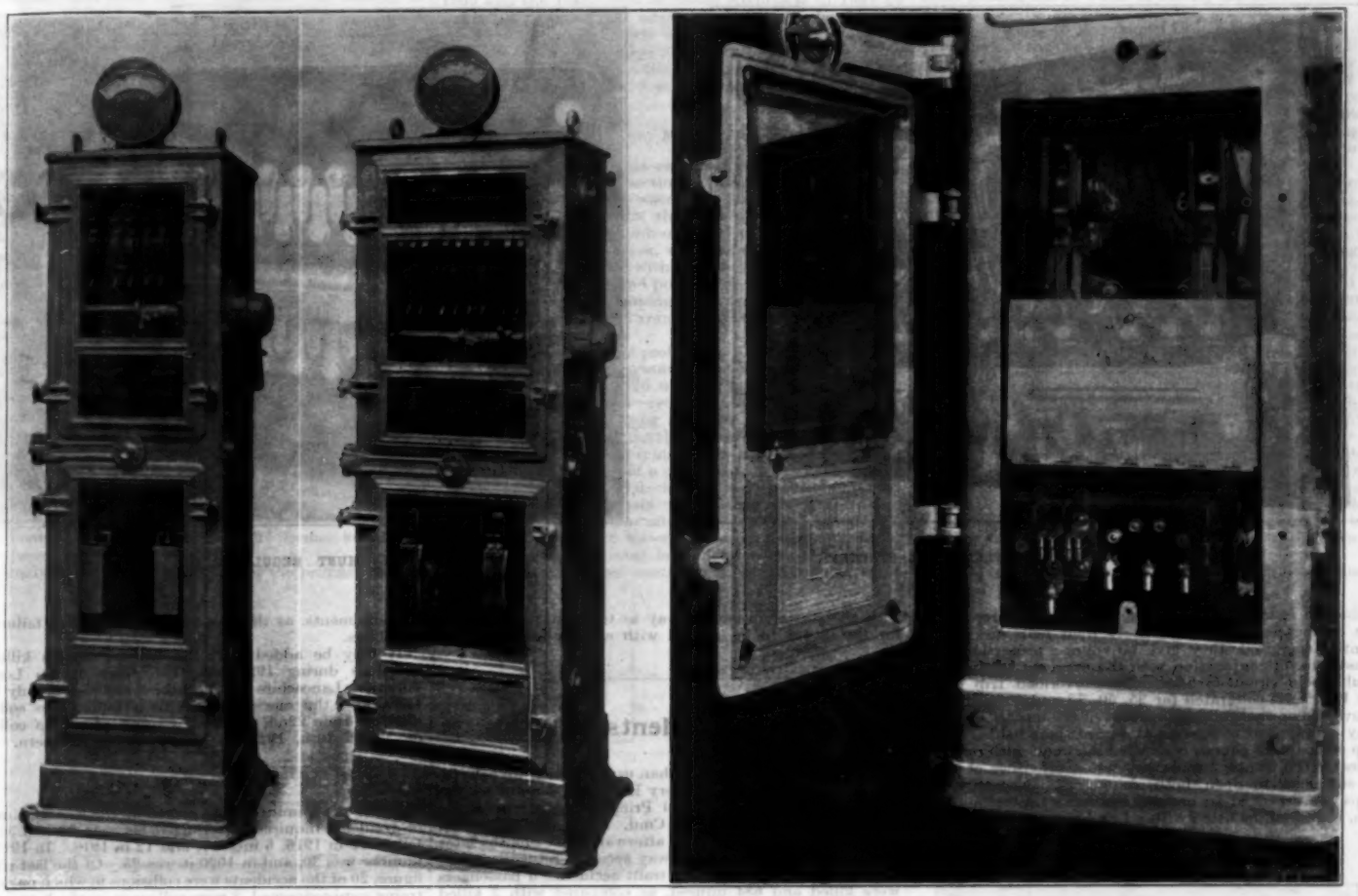
New Switchgear.

THE last report issued by Mr. G. Scott Ram, H.M. Inspector of Factories, stated that the number of accidents of an electrical nature during the year 1920 was 394, and although that number is perhaps not tremendous, when the extent to which electricity is now utilised is taken into account, it is obviously desirable that it should be diminished in the future. Of the low and medium-pressure accidents, many, it is said, were attributable to badly designed apparatus or to inadequate protection, whilst others were due to carelessness or ignorance on the part of the persons injured. Apart altogether from the desirability of preventing accidents in the interests of industrial efficiency, legislation relative to this matter is steadily becoming more severe, and manufacturers who are constructing switchgear which is absolutley safe are merely adopting measures which may become in some degree compulsory in the near future. Many forms of switches are, of course, handled by skilled men, and switches are often placed in positions where they are not likely to give rise to accidents. An automatic contactor controller operated from a distance by a push button is a type of switch which does not demand special safeguards, but in the case of an ordinary industrial motor starter which has to be operated at frequent intervals by workers who are devoid of electrical knowledge, adequate protection is obviously required.

Some new switchgear which has recently been brought to our notice by Brook, Hirst and Co., Limited, of Chester, has been designed to overcome the troubles that often occur and seems to conform with the requirements of many users of electric motors. The starting panels shown in Figs. 1, 2 and 3 are equipped with a new type of multiple-lever starter which is claimed to offer marked advantages. All the parts of the gear associated with the panels—starter, double-pole circuit-breaker, shunt regulator, &c.—are enclosed in a stout sheet steel case as employed by the makers for many years past. By enclosing the parts in this manner, the inconvenience associated with a number of separate parts and troublesome interconnections are avoided, whilst at the same time the glazed front doors allow the operation and condition of the switchgear to be seen without the least difficulty. By the adoption of these arrangements the operator is to a certain extent protected, but the most important feature is the provision of an efficient door-locking device which prevents the doors being opened whilst the panel remains alive. To achieve this result a double-pole isolating switch is fitted in the panel, and the function of the door-locking arm is to ensure that the doors cannot be opened until that switch is in the "off" position.

The locking arm—shown in Fig. 4—carries at the hinged end a projecting stop which prevents any movement on the part of the locking arm or doors until the locking cam, which consists of a cast iron circular disc having a portion cut away, is in the correct position. This locking cam is mechanically coupled to the handle of the isolating switch, and it cannot be in the position which enables the door to open unless the isolating switch is "off." The cast iron locked box totally encloses the locking arrangements, which cannot fail to operate unless they are completely removed from the panel. These arrangements, therefore, ensure that the isolating switch must be in the "off" position, and must remain in that position as long as the doors remain open. The only parts that then remain "alive" are the main terminals and the supply side of the isolating switch itself, but in order to avoid operators receiving shocks from these parts the chamber which contains the parts is sealed by a door which can only be opened by an authorised person. A view of the lower chamber, which contains the isolating switch and main terminals, is shown in Fig. 3, where the door of the lower chamber is raised. The makers believe that this form of gear constitutes one of the most substantial devices so far designed, and point out that it is difficult to conceive circumstances under which contact could be made with live parts.

As regards the starter itself, which is shown in Fig. 5, the lever switches are operated by a horizontal drum which carries a series of cams, and the operating drum is actuated by a ratchet handle, so as to ensure that the lever switches operate slowly and in the correct sequence. Each lever switch is constructed on simple and robust lines, being composed entirely of stampings and extrusions. The contact pressure is maintained at a constant value throughout the life of the switch by compression springs, whilst in order to secure a rolling action at the point of contact, the contacts are curved, and are given a considerable section so that wear may take place very slowly. From the initial to the final point of contact the rolling movement of the contacts is maintained, and when the switch is opened the action is reversed and the circuit is broken at the initial position. Two flat steel springs give a positive quick-break action, and the balance of the switch avoids rebound. Under no circumstances are the switches called upon to break the full current, as the circuit is always opened by two electrically operated contactors, which are fitted with magnetic blow-outs. With the above form of construction a long wearing period for the contacts is secured, and when they eventually need renewing the operation of replacing them is of the simplest character. Care has also been exercised to ensure that the flexible braids shall be subjected to as little stress as possible. A strip of copper gauze minimises the effect of bending, whilst copper strands running through the braids serve to increase the current-carrying capacity. The starter



FIGS. 1 AND 2—STARTING PANELS FOR CONSTANT AND VARIABLE SPEED MOTORS

FIG. 3—LOWER PORTION OF PANEL SHOWING ISOLATING SWITCH

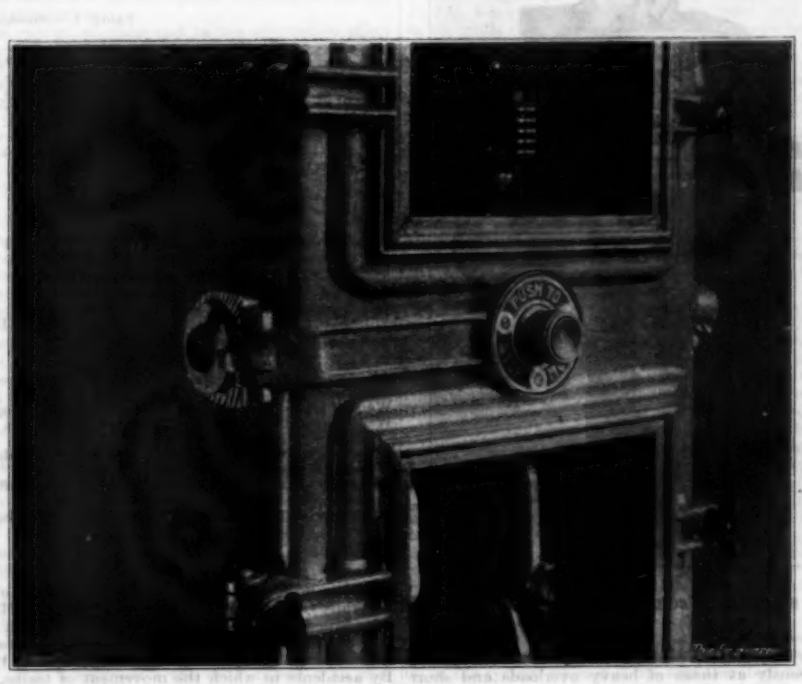


FIG. 4—DOOR LOCKING GEAR

is fitted with a true "free handle," which is effective under overload conditions, failure of supply or interruption of the starting operation. It can be operated by one hand, and there is no button to keep depressed during the starting period. The electrically operated contactors mentioned above are interlocked with the starter so that they cannot be closed unless the whole of the starting resistance is inserted in the main circuit. Moreover, as the contactors open immediately their coils are insufficiently energised, they give no-voltage protection, and constitute, in conjunction with the overload trips, a true double-pole circuit-breaker. Each overload trip coil—see Fig. 7—is calibrated for 25, 50, 75 and 100 per cent. above the normal full load current of the motor, and they may be adjusted to operate at any of these loads. These trip coils are, of course, connected in circuit with opposite poles of the supply, and the action of either of them is sufficient to open both contactors. Normally, the trips are arranged to operate instantaneously, but they can, if desired, be fitted with oil dashpot time lag devices,

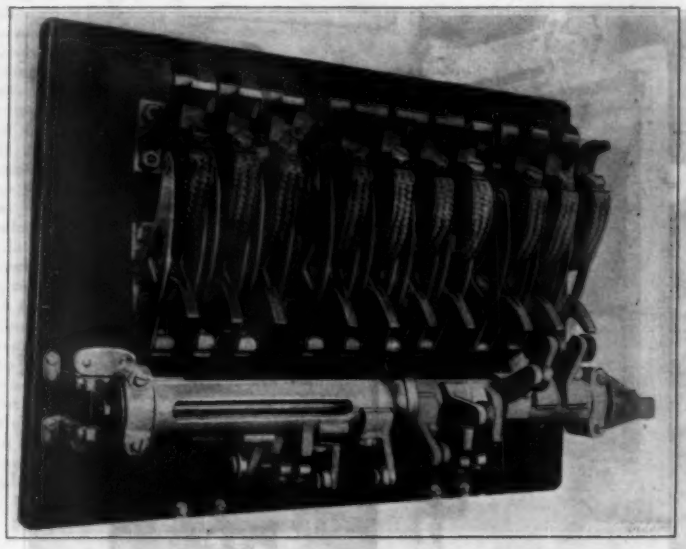


FIG. 5—BROOK-HIRST MULTIPLE LEVER STARTER

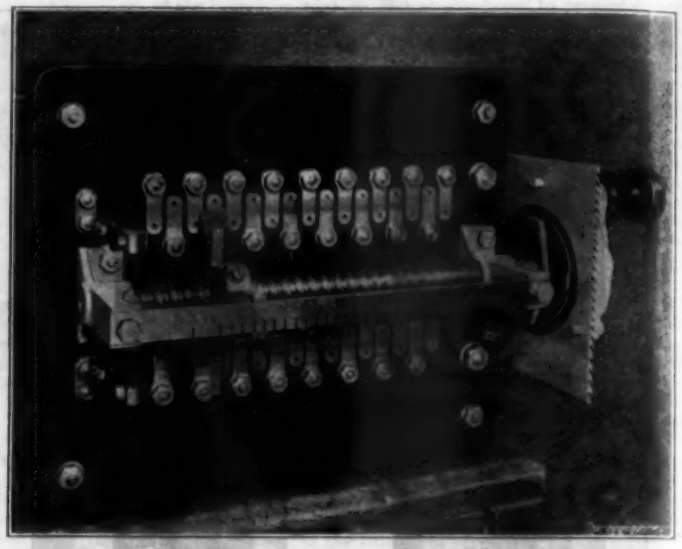


FIG. 6—SHUNT REGULATOR

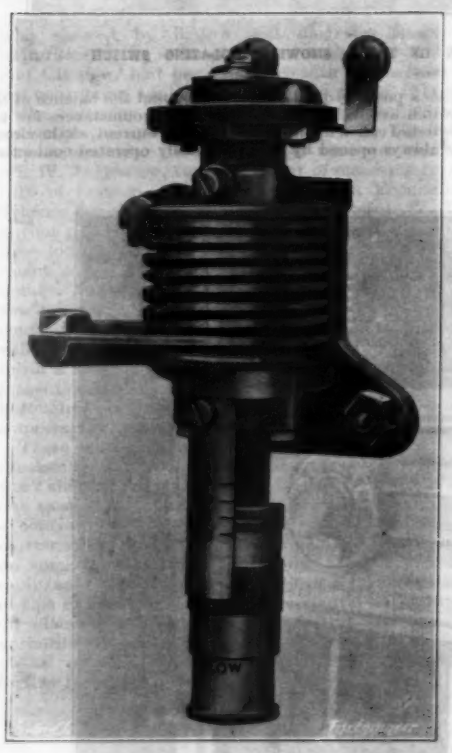


FIG. 7—TRIP COIL WITH TIME LAG

which are adjustable, and allow the trips to operate instantaneously at times of heavy overloads and short circuits.

The shunt field speed regulator, as shown in Fig. 6, differs from the usual face plate type, in that the contact segments are arranged in two parallel straight lines, and the contacts at the top are staggered relative to those at the bottom. The regulator is operated by a horizontal screw which causes the movable contact, consisting of a laminated copper brush, to slide over the surface of the segments, and the regulator is claimed to offer the advantage of enabling a larger number of segments to be got into a given space than when the segments are arranged circularly. The arrangement also gives a convenient sliding movement whilst the screw drive gives a true slow motion without the use of any complicated arrangements. The contact pressure between the moving brush and the segments is also maintained at a practically constant value throughout the life of the brush. When necessary, both the brush laminations and the segments are easily replaced, but the contacts are nevertheless designed so as to ensure a long life. The regulator is interlocked with the starter in such a way as to make it impossible for the motor to be started with a weak field.

Railway Accidents in 1920.

QUITE three months later than usual owing, we believe, to the activities of a Stationery Economy Committee, the general report above Colonel Pringle's signature on the railway accidents in 1920—Cmd. 1366—was issued on the 28th ultimo, and a week afterwards, six months later than usual, appeared the railway accident returns.

The report shows that in train accidents 6 passengers were killed and 684 injured, as compared with 3 killed and 513 injured in 1919, and with an annual average of 39 killed and 620 injured during the ten years 1909–1918, which period, we may remind our readers, includes the 224 killed and 242 injured at Quintinshill in May, 1915. There were 5 servants killed and 177 injured, as against 7 killed and 114 injured in 1919, and an annual average of 8 killed and 143 injured during the ten years 1909–1918. In other accidents caused by the movement of trains—generally called "movement accidents"—371 servants were killed and 4237 injured, as compared with 318 killed and 3845 injured in 1919, and an annual average of 367 killed and 4411 injured during the ten years 1909–1918. By accidents in which the movement of trains, &c., was not concerned—generally known as "non-movement accidents"—44 servants were killed and 17,514 injured, as against 52 killed and 16,489 injured in 1919, and an annual average of 46 killed and 21,687 injured during the ten-year period 1909–1918.

NUMBER OF TRAIN ACCIDENTS.

The following figures for 1920 and 1919 are taken from the returns, and to them we have added those for 1913, the last pre-war year. It may also be observed that in 1920 there were 1604.4 million passenger journeys, exclusive of those by season ticket holders, in 1919 there were 1551.7 million, and in 1913 there were 1452.7 million passengers. The train mileage in 1920 was 378.0 millions, in 1919 there were 348.9 millions, and in 1913 there were 435.3 millions.

The explanation for the apparent increase in the number of goods train collisions, and especially in those of goods train derailments, is that collisions and derailments arising out of the failure of couplings are now returned as collisions or derailments, as the case may be, as well as failures of couplings.

It may be added that the five passengers killed in collisions during 1920 lost their lives in the Lostock Junction, Lancashire and Yorkshire, collision of July 17th, 1920, and the one passenger in a buffer-stop collision died on June 22nd, 1920, as a result of such a collision on March 10th, 1920, at Firsby, Great Northern.

ACCIDENT INQUIRIES.

In the years immediately preceding the war the number of accidents inquired into ranged between 20 and 30. It fell to 12 in 1916, 6 in 1917, and 12 in 1918. In 1919 the number was 30, and in 1920 it was 25. Of the last-named figure, 20 of the accidents were collisions in which passenger trains were concerned, 2 were collisions in which passenger trains were not concerned, 1 was a derailment of a passenger train, and 2 related to fires in trains. They may be, in respect of primary causes, roughly allocated as follows:—(*a*) Failure or insufficiency of equipment, 7; (*b*) failure of enginemen to obey or observe "danger" signals, 6; (*c*) failure of enginemen to give effect to regulations, 4; (*d*) failure of signalmen to observe or give effect to regulations, 7; (*e*) failure of traffic staff to carry out correctly coupling duties, 1. Of the 7 cases in (*a*), 2 indicated the necessity for improved means of detecting facing points, 2 for better maintenance of brake equipment, and 2 emphasised the importance of more immediate and reliable means of removing electrical traction pressure. We would observe, as to the last, that the two fires in question occurred practically simultaneously on the Baker-street and Waterloo and the Piccadilly tubes.

In 5 out of the 10 cases originating in failure on the part of enginemen, a system of automatic train control—a subject which is now under consideration by a committee appointed for the purpose—would have had beneficial effects. In other cases the exercise of proper caution on the part of enginemen is generally the remedy. In 2 of the 7 cases of failure on the part of signalmen the introduction of track-circuiting would check such liability to error. The other cases would have been prevented by

TABLE I.—*Number of Train Accidents and Resultant Casualties.*

	1920.					1919.					1913.				
	No. of accidents.	P's'ng'rs.		Servants.		No. of accidents.	P's'ng'rs.		Servants.		No. of accidents.	P's'ng'rs.		Servants.	
		K.	I.	K.	I.		K.	I.	K.	I.		K.	I.	K.	I.
Collisions involving passenger trains	101	5	440	1	30	93	1	279	—	29	109	32	570	5	33
Collisions not involving passenger trains	187	—	4	2	85	135	—	—	1	44	116	—	1	1	77
Buffer-stop collisions due to unsuitable speed	11	—	38	—	2	9	—	11	—	—	9	—	28	—	2
Buffer-stop collisions due to other causes than unsuitable speed	41	1	106	—	15	42	1	178	—	6	25	—	68	—	2
Derailments of passenger trains	87	—	23	—	3	93	1	21	—	3	73	1	19	1	—
Derailments of goods trains	472	—	—	—	15	434	—	—	1	7	215	—	—	1	20

TABLE II.—*Causes of Movement Accidents.*

	Fatal.	Percentage.	Non-fatal.	Percentage.
Misadventure or accidental	98	26.70	2784	65.82
Want of caution or misconduct on the part of the injured person	235	64.03	1011	23.90
Want of caution or breach of rules, &c., on the part of servants other than the persons injured	18	4.90	261	6.17
Defective systems of working, dangerous places, dangerous conditions of work, or want of rules or systems of working	8	2.18	42	0.99
Defective apparatus, appliances, &c., or want of sufficient appliances, safeguards, &c.	6	1.64	122	2.88
Neglect or non-observance of rules under the Railway Employment (Prevention of Accidents) Act, 1900	2	0.55	10	0.24

obedience to, or correct procedure in connection with, regulations.

Other lessons learned from the year's experience include :—(1) Necessity for ensuring that firemen and porters have the desired experience in footplate and brake-coupling duties ; (2) desirability of shortening the period during which it is necessary to work traffic under block regulation No. 25 by the adoption of a temporary method of telegraphic communication ; (3) the necessity for well-defined co-operation between signalmen in connection with signal—and point—lever operation ; (4) liability to misreading of fixed signals placed outside a number of running roads by enginemen.

In sixteen cases recommendations were made which have been wholly or partially complied with ; in two cases recommendations were made which are under consideration ; in four cases no recommendations were made.

Accidents to Railway Servants.

In "movement" accidents, as has already been said, 371 servants were killed and 4237 injured during 1920. Of these, 15 were killed and 543 injured when coupling or uncoupling vehicles, 16 were killed and 546 injured when braking or spragging wheels, 9 were killed and 345 injured when moving vehicles by capstans, turn-tables, &c., 50 were killed and 883 injured in other shunting accidents, 12 were killed by coming in contact with overbridges or erections on the sides of the line, 793 were injured while attending to the machinery of engines in motion—the most prolific of the twenty-one causes of injury—71 were killed and 146 injured while walking or standing on the line on duty at stations, and 43 were killed and 37 injured when on the line on duty elsewhere than at stations, and 30 were killed and 24 injured going to or from work. It will be observed that of the last two classes of accidents the proportions that prove fatal are 53.7 and 55.5 per cent. respectively.

Amongst the permanent way men (74,443 employed) 105 were killed, amongst shunters (19,617) 46, goods guards (18,435) 41, and firemen (37,014) 27. That the fireman has a more hazardous job than the driver is suggested by the fact that 15 were killed and 472 injured of the latter (38,762 employed), as compared with 27 firemen killed and 820 injured.

An analysis is given in the report of the primary causes of 367 of the fatal and of 4230 of the non-fatal "movement" accidents. They are as given in Table II.

Of accidents to servants, 433 were inquired into by the assistant inspecting officer and the sub-inspecting officers. The causes assigned after the inquiries and the causes given in the 4164 cases not inquired into were :—Misadventure or accidental, 62.693 per cent. ; want of caution or misconduct on the part of the injured person, 27.105 per cent. ; want of caution or breach of rules, &c., on the part of servants other than the person injured, 6.069 per cent. ; defective systems of working, dangerous places, dangerous conditions of work, or want of rules or systems of working, 1.088 per cent. ; defective apparatus, appliances, &c., or want of sufficient appliances, safeguards, &c., 2.784 per cent. ; neglect or non-observance of rules under the Railway Employment (Prevention of Accidents) Act, 1900, 0.261 per cent.

In 192 cases out of the 433 inquired into, recommendations were made, of which 129 were adopted, 28 were not adopted, and 35 are under consideration.

It is difficult to assign more than 4.1 per cent. to preventable causes. Of the great bulk of the remaining 95.9 per cent., Colonel Pringle observes that "improvement in the returns can only be obtained by educating the men in personal carefulness and generally in extending the safety movement among employees."

The 44 fatal and 17,514 non-fatal non-movement accidents are those in goods sheds, engine sheds and about station premises. A remarkable feature about them is that whilst there is an increase of, we estimate, 15 to 20 per cent. in the number of persons employed, the number of non-fatal accidents has been decreasing. The explanation, we suggest, is that "sick pay" is now so much less than regular pay that the men are loath to "report sick." The report says that 95 per cent. of the accidents were of a more or less non-preventable character. Only 1.4 per cent. could be attributed to defective apparatus or want of sufficient appliances, safeguards, &c.

Model General Conditions for Contracts.—The work of revising the Institution of Electrical Engineers' "Model General Conditions for Contracts," which began in April, 1920, was completed at the end of last session, and a new edition was published on the first of this month. In addition to the members of the committee of revision nominated by the Institution, the committee included a number of representatives of other associations within, or closely connected with, the electrical industry, and through these representatives the committee had the benefit of the views of the governing bodies of the various associations interested in the "Model General Conditions for Contracts." The new conditions have been issued in such a form that they can be used as the actual contract by filling in the blank spaces.

The Machinery of Floating Docks.*

By E. H. SALMON, D.Sc., of London.

The floating dock has long since established its position as one of the most widely used appliances for docking ships. Nevertheless, with the exception of an occasional article in the technical Press, it is believed that since the papers read before the Institution of Civil Engineers in 1905 and the Institution of Naval Architects in 1907 by Mr. Lyonel Clark, with whose name the development of the modern floating dock will always be connected, no memoir on the subject has appeared.

The subject may be divided into four parts :—(1) Pumping machinery, (2) control gear, (3) auxiliary machinery,† (4) berthing gear.

Pumping Machinery.

The floating dock in its essentials is a hollow steel box of U or L-shaped cross section. This box is sunk to some desired depth by letting water into the interior, and while in this sunken condition the ship is hauled on to the pontoon or horizontal limb of the U or L. Water is then pumped out from the dock, which causes it to rise, carrying, of course, the ship with it, the operation being continued until both ship and pontoon deck are high and dry. The function of the pumping machinery is to remove this water. Alternatively, arrangements must be made for admitting water at will.

The magnitude of the problem in a large dock may be better judged when it is stated that some 60,000 tons of water have to be removed from an area of 11,000 square feet—that is, 2¼ acres—requiring ten pumps of 20in. diameter of outlet running for three hours, each driven by an engine or motor developing some 200 horse-power.

This operation of pumping out a floating dock differs from that of pumping out a graving dock or similar structure, in that the floating dock has always to be maintained on a level keel. To obtain this balance, the dock is subdivided in both directions into a number of compartments, from any one of which water can be removed at pleasure. The whole operation must be under the complete control of one man at a single control station. Similarly, while lowering the dock, it must be possible to admit water into any desired compartment.

The usual system of pipes and valves adopted to effect this control consists of a gridiron arrangement of pipes, one leading to each compartment from a continuous main drain. Each compartment pipe is governed by a direct-lift valve operated from the control station. The pumps draw from the main drain, while the inlets are provided to deliver into the main drain when the dock is being lowered. Each inlet and pump discharge is governed by a screw-down valve on the sea side. In this manner it is possible to fill or empty any single compartment at will and the dock is completely under control.

In very small docks there may be only one main drain and one pump ; in large docks several separate systems, each with its main drain and pump or pumps. These separate systems are usually interconnected, so that the pumps of one system can, if desired, draw from the main drain of the others, suitable valves being introduced. In this case, should one pump break down, it is still possible to raise the dock, though, of course, in a proportionately longer time.

The size and arrangement of the compartments is usually determined by questions of stability, and in some degree of convenience in handling. To these considerations the pumping arrangements have always to be subservient. In modern docks, however, a great deal of attention has been paid to the arrangement of the compartments, and particularly to the introduction of sealed compartments or air chambers, into which the water is never allowed to enter, with the idea of reducing the work done and the amount of water pumped in raising the ship and dock. To understand this question it is first necessary to consider a little in detail on what the work done and water pumped depend.

Fig. 1 represents the dock in its sunken condition. Two equal and balanced forces act on the structure, namely, its weight W acting at the centre of gravity, and the upward buoyancy B equal to W acting at the centre of buoyancy. Fig. 2 represents the dock raised with the pontoon deck awash. The same two equal forces occur, but their relative position is different. Now, the work done in raising the dock is evidently the weight W times the distance it moves, minus the buoyancy B times the distance it moves, that is,

$$\text{Work done} = W \times H_2 - B \times H_1 = W\,(H_2 - H_1),$$

since W = B. Evidently, therefore, if H_1 could be increased by lowering the centre of buoyancy in Fig. 1, when the dock is sunk, the work done could be diminished.

* The Institution of Mechanical Engineers.—Abstract.

† The section on auxiliary machinery is here omitted, while that on pumping machinery has been contracted.—Ed. The E.

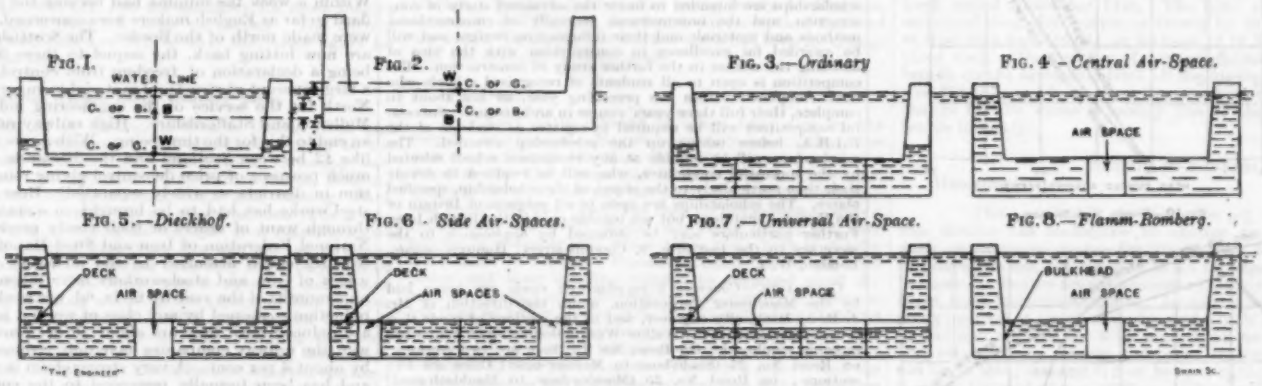
The method adopted to effect this is to transfer buoyancy from the vertical caissons, usually called the side walls, to the horizontal caisson, or pontoon proper, by sealing up certain of the pontoon compartments, thus making them into permanent air chambers—see Fig. 5. Roughly speaking, some 80 per cent. of the dock's weight may be "balanced" in this way, and a considerable saving in horse-power effected.

The amount of water to be pumped is not affected by this device, for it is evident that for every ton of displacement pushed out of water in raising the dock, one ton of water must be pumped from the interior. Hence, the weight of water to be pumped is equal to the loss of displacement of the dock as it rises (including that of the ship, if a ship is being lifted). This figure depends chiefly on the dimensions of the side wall, and is independent of the weight of the dock and the arrangement of the compartments. Nevertheless, it is not necessary that all the water should pass through the pumps, and by suitably arranging the compartments the size of the main drain and pumps may be considerably reduced.

Suppose a water-tight deck or bulkhead be introduced, dividing the side wall from the pontoon proper, Fig. 5. If, now, water be pumped from the pontoon compartments, it is evident that, as the dock rises, a position will be reached when the water in the side walls is at a higher level than the water outside. Then it is only necessary to open a suitable valve at the bottom of the wall and let the water run out as the dock rises. In this way 20 to 25 per cent. of the water may be run in and out of the dock without passing through the pumps at all. There is considerable saving in pipe friction and in the diameter of the pumps and main drain—a useful feature in large docks.

Both these devices are quite well known and by no means new. Rennie, in his patents of 1860 and 1863, showed both the air space and the water-tight deck. More recently, however, a good deal of investigation has been made on the effects of fitting air spaces and water-tight separation decks, both with regard to saving in pumping power and also with regard to their influence on the stability and weight of the dock. Both air space and separation deck work well in practice. Their employment gives rise to a number of different types of dock which are shown in Figs. 3 to 8.

Fig. 3 represents the ordinary system with no air space,



for the dock to carry up with it a considerable body of water in the side walls after the pontoon deck is above water, which water quietly runs out afterwards. In fact, all docks carry about up 4in. to 6in. of water all over the pontoon deck as the latter emerges, in spite of the large watershed formed by the ends of the dock and the usual deck drainage system, so that it is not a question of valve area at all.

It is therefore necessary to reckon on a longer time of sinking for a dock with air chambers, particularly if a separation deck be fitted, and in practice this type of dock has undoubtedly the tendency to sink slowly. In many cases this is immaterial. It merely means that the operation of sinking the dock must be started so much earlier. In busy ports, however, where the dock must be sunk at very short notice to lift a vessel, the time of sinking is a more serious matter, and it is not uncommon for a definite time of sinking to be specified. In such cases the advantage of an air space has to be very carefully considered.

A second and more serious objection to the introduction of the air space and separation deck is that it adds to the weight of the dock. It is evident that the framing in the air space is much heavier than that outside. In a large dock the head of water on the bottom under the air space may amount to 60ft. Secondly, the bulkhead which bounds the air space is very considerably heavier than the normal bulkheads. Against this, the framing in the side walls may be made considerably lighter owing to the separation deck, although, of course, the weight of the deck—no small item—is an addition to the weight of the dock. The advantage has to be balanced against the disadvantage. In a large dock it may be possible to save sufficient weight on the walls to balance the increased weight in the pontoon. In a small dock there are limits to this saving, because it is undesirable to reduce the thickness of the scantlings below the limits which good

FIG. 9.—*Head Curves*

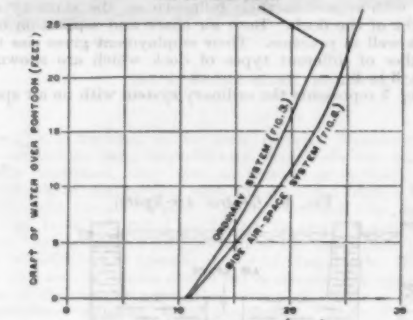
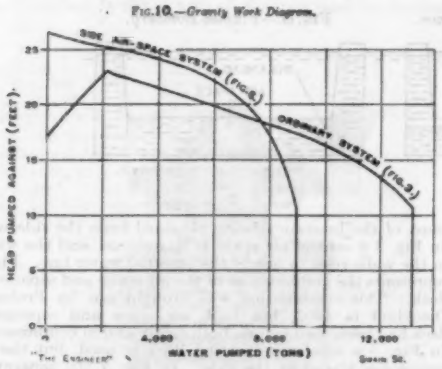


FIG. 10.—*Gravity Work Diagram.*



practice determines for metal work immersed in water, and as a rule the saving in pumping power is made at the expense of considerable increase in first cost. Again, a central air space as a rule involves very wide side compartments, and the width of the side wall has to be increased to obtain the necessary stability. To divide this compartment into two, as, for example, in the Flamm-Romberg system, doubles the number of compartment pipes and valves and all the necessary valve gear, with the attendant increase in first cost—again a doubtful expedient.

Recently, considerable attention has been given to the question of design in order to obtain the advantage of the air space without the disadvantages, and a certain measure of success has been obtained. This is rather a question of hull design than machinery, and is beyond the scope of this paper.

The introduction of the air space and separation deck has one consequential effect which has to be taken into account when designing the pumps, and that is, that it greatly modifies the shape of the curve showing the heads against which the pumps have to throw. This is illustrated clearly in Fig. 9, which represents the head curves for the two different types indicated at all positions during the lift. Fig. 10 shows the same curves plotted on a base line representing the amount of water thrown by the pumps.

The area of a curve of the type shown in Fig. 10 evidently represents the work done against gravity in raising the dock. In order to obtain the total work done, the work expended on friction in pipes must be added. This latter is calculated by Unwin's or Weisbach's formula, due allowance being made for bends, changes in velocity and direction, &c. Usually the loss due to friction in pipes is from 10 to 30 per cent. of the total work, getting larger as the size of the pumping plant decreases.

Knowing the total work done, the theoretical or water horse-power of the dock follows at once. To obtain the indicated horse-power it is necessary to allow for the efficiencies of the pumps and motors or engines. Here a little caution is necessary. The efficiency of the pumps and motors or engines on the test bed is very different from the efficiency of the same plant averaged over a lift. As will be seen from Fig. 10, there is a considerable variation in the gravity head. True, the increased velocity of output at the low heads tends to level matters up to some extent, in that the frictional head is correspondingly increased; but nevertheless the efficiency over a large part of the lift is bound to be reduced. Not only so, but towards the end of the lift it is almost inevitable that the pump will draw a certain amount of air, which again tends to destroy its efficiency.

Now, in a calculation based on the total amount of work done, it is necessary to allow for the average efficiency in order to get the average horse-power, and it is found in practice that this average efficiency is for the pumps about 55 per cent., for the shafting, say, 95 per cent., and for the engines about 75 per cent. In other words, the ratio

$$\frac{\text{Water horse-power}}{\text{Indicated horse-power}} = 0.4 \text{ approx. averaged over the}$$

whole lift. During parts of the lift the efficiency of both pumps and engines will no doubt be higher, but during a considerable portion it will be lower.

(To be continued.)

TRADE SHIP.—The directors of the British Trade Ship, of which Earl Grey is chairman, announce that provisional tenders are being obtained by the builders of the ship for the various parts and fittings. Exhibitors who are in a position to supply some part or fitting as an exhibit actually in use on board, quite apart from their display in the exhibition proper, are naturally anxious to have their products accepted for this purpose. The examination of the specifications is of interest as revealing the place of different cities in the construction and equipment of the Trade Ship. Birmingham wants its bedsteads in the best cabins; Kidderminster its carpets; Bradford its textiles, not only on show but in use; Sheffield its cutlery; and so on with hardware, machinery, leather, glass and electrical goods. The test which the builders will apply in all cases is that of quality, and unless an exhibitor can satisfy them that his product is of the highest quality, it will not be included as part of the structure or of the fittings of the ship.

THE "ARCHIBALD DAWNAY" SCHOLARSHIP.—In accordance with the terms of the will of the late Sir Archibald Dawnay, the Royal Institute of British Architects offers annually, for competition between students of recognised schools, three scholarships, two of £50 per annum for two years (£100 in all) and one of £25 per annum for two years (£50 in all) The scholarships are intended to foster the advanced study of construction, and the improvement generally of constructional methods and materials and their influence on design, and will be awarded for excellence in construction with the idea of assisting the winner in the further study of construction. The competition is open to all students of recognised schools who have completed within the preceding year, or are about to complete, their full three years' course in architecture. Successful competitors will be required to register as students of the R.I.B.A. before taking up the scholarship awarded. The scholarships will be tenable at any recognised school selected by the successful candidates, who will be required to devote their time particularly to the object of the scholarship, specified above. The scholarships are open to all subjects of Britain or the British Dominions, but are tenable only in the British Isles. Further particulars may be obtained by application to the secretary to the Institute, 9, Conduit-street, Hanover-square, London, W. 1.

CONTRACTS.—Concrete town-planning roads are being laid by the Manchester Corporation, under the direction of Mr. J. B. L. Meek, city engineer, and in the sections of roads that are being reinforced the Walker-Weston double-layer framework is being employed. On Road No. 12 there are two sections; on Road No. 25 (Slade-lane to Moseley-road) there are two sections; on Road No. 25 (Moseley-lane to Mauldeth-road) there is one section. At all these places the road is constructed on filling, and the reinforcement used is that known as "Pattern B," and weighs 16 lb. per square yard. The width of the roads between the kerbs is 20ft., and the reinforcement is carried underneath the kerb for 18in. on either side of carriageway.—A contract for fifty bungalows and other structures in connection with railway building in Central Africa has been secured by Boulton and Paul, Limited, of Norwich. They are to be timber structures with steel supports, and are to be carried out in the usual manner adopted by the firm for tropical buildings. We understand that, in addition to these bungaows for Africa, there are ten others for Ecuador, Central America, in the course of construction. The latter are being built in steel to the firm's registered design, and are planned for easy erection by native unskilled labour. There are also in the shops five bungalows constructed of steel and timber framing for Mozambique.

INSURANCE OF DIESEL ENGINES AGAINST BREAKDOWN.—The amended arrangements made by the Insurance Committee of the Diesel Engine Users' Association for the insurance of Diesel engines against breakdown, including periodical inspection and reports by engineers having special Diesel engine experience, were reported at the last meeting of the Association. The standard form of policy which was adopted by the Association some six years ago has been amended in some respects as a result of experience gained. It was pointed out at the meeting that the main object of the insurance of this class of risk should be to provide against heavy loss in the case of an unfortunate serious mishap and to secure the advantage of independent inspections and reports by thoroughly competent engineers having special experience of the working of the various types of Diesel engine, and not to encourage small claims in connection with little troubles which might properly be chargeable to the maintenance account. It had been found that certain engineers did not appear to think that they were getting proper value for the insurance premium paid unless they took every possible opportunity of making little claims which should properly be included in the maintenance cost, and the result of which could only be to discourage the underwriting of such risk and to keep up the premiums. Various insurance companies that had undertaken this class of risk from time to time had not found it profitable, and the object of the Association in adopting a standard policy and in arranging for its use by an insurance company was not only to provide for efficient inspection and reports, but to concentrate the business as far as possible in one direction, as it was only by spreading the risk over a large number of undertakings that the premiums could eventually be brought down. A preferential rebate is allowed off the premiums to all Diesel engine installations, the engineers or managers of which are members of the Diesel Engine Users' Association. An important provision under the standard policy is that which provides for arbitration in the event of a dispute without having recourse to the expensive method of proceeding under the Arbitration Act. In the event of disagreement in the interpretation of the policy the matter may be submitted for arbitration to a special committee of the Diesel Engine Users Association. The services of this committee as arbitrator are, however, only available if the engine user is a member or subscriber of the Association. Particulars of the scheme of insurance under this standard Diesel engine policy can be obtained on application to the honorary secretary of the Association at 19, Cadogan-gardens, S.W. 3.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Successful Colonial Tendering.

IT is not yet generally known, but I am in a position to state that a large Colonial engineering contract has just been secured by a local engineering firm, and I desire very heartily to congratulate the Birmingham district upon the circumstance. The contract in question is one for £280,000, and relates to water-tube boilers, the successful firm being John Thompson, Limited, of Ettingshall, near Wolverhampton, and the destination is close to Melbourne. I need scarcely say that the receipt of the work has created the liveliest satisfaction in the Birmingham district, since it will mean employment for a large number of workpeople for some time to come.

The Steel Position.

In the steel department the British makers have recovered the command of the markets, being able to deliver billets at £8 per ton, as against the Belgian figure of £8 12s. 6d. The determination of Scotland to act independently of associated prices has introduced a new element of keenness into the competition. For several months the steelmakers of the country have been free to quote cutting prices on foreign business, and this independence is now extended to home orders. Rather keener competition is expected in steel now that Scotland has decided to abandon Association prices. British prices are practically uniform. The decision of the Scottish steelmakers to remove price restrictions from structural steel shows how severely the solidarity of trade organisations is being strained by the depression. When the associated makers conferred on the situation a month ago, the English makers found it was only possible to avoid disruption by fixing the minima for plates, angles and joists so much below the current price of production that many firms could not see their way to make the drop all at once. The Scottish makers took an independent line, expressly dissociating themselves from the arrangement. Within a week the minima had become the general standard so far as English makers were concerned, and inroads were made north of the Border. The Scottish steelmakers are now hitting back, the sequel to these developments being a declaration of freedom from control. Normally a large amount of structural material is imported from the North for the service of the engineering industry in the Midlands and Staffordshire. High railway rates have put an end to this for the time being. With a rate of something like £2 between Scotland and the Midlands, there is not much prospect of price de-control giving rein to competition in districts so widely separated. Here and there a steel works has had to be brought to a standstill, either through want of orders or their costly production. The National Federation of Iron and Steel Manufacturers has recently called attention to the fact that whereas the wages of iron and steel workers have fallen in the first nine months of the year by £1 7s. 6d. per week, the largest reduction sustained by any class of worker, and fuel costs are reduced until they are about 50 per cent. above pre-war, the railway companies have only reduced their rates by about 4 per cent. A very strong claim is put forward, and has been formally presented to the companies, for further reductions as the only means of getting the idle blast-furnaces back to work. The demand for steel half products is stated to be well maintained, though the possible cancellation of the battleship contracts has had its effect in modifying plans for increased output. The steel bar trade is being sharply cut. As low as £10 10s. has been quoted for bars (five-eighths basis), and £11 is about high-water mark for this material. These bars are rolled from foreign billets, and houses that produce all-British bars, and who quote £12 10s., have no chance in competition. The Staffordshire price for steel hoops is £13 10s. at works. Lancashire makers quote £14 5s. delivered in this district, and £14 for export trade. The latest statistics of production are rather discouraging since the output of steel has fallen from 434,000 tons in August to 405,000 tons in October, compared with 754,000 tons, the monthly average of 1920. The position would have been much worse but for a marked recovery in South Wales, which has to some extent counterbalanced the heavy fall in other districts.

Manufactured Iron.

Cutting is becoming more severe in the unmarked bar trade. The Association price of £14 10s. has for some time past ceased to represent the actual position. Endeavours by unassociated firms to force the pace by lowering the price have provoked retaliation and control is only nominal. Mills are quoting £14 while some firms are stated to be willing to accept orders at £13 5s. and to make substantial concessions in regard to extras. Continental quotations are not much above £10, but demand is so sluggish that few orders are now being placed abroad. Belgian shippers are trying to get orders, and are quoting £9 10s. delivered, in place of £10 to £10 5s. some little time ago. The nut and bolt industry, which ordinarily takes a big tonnage of iron bars, is now running to a great extent on steel, which can be bought from British sources at about £10 15s. Profound depression still overhangs the nut and bolt trade, and manufacturers who specialise in Admiralty work and who were expecting a good deal of work in connection with the building of the four capital ships, have received a severe set-back by the suspension of work for these vessels. The marked bar houses continue fairly busy. They were expecting to benefit by the new shipbuilding contracts as the work progressed, and should these be cancelled as the result of the Washington Conference the iron trade will temporarily suffer. The improvement which continues in the galvanised sheet trade is not so noticeable in the Midlands as at the large works near the coast. South Staffordshire firms are not as a rule operating at more than 25 per cent. capacity. Promising inquiries are to hand from South Africa. Prices are variable, ranging from £18 to about £19.

Pig Iron Cheaper Still.

The principal feature of the iron trade this week has been a further fall in pig iron amounting to about half a crown. This reduction in values is really the continuation of the decline that has been in progress with some intermission since the momentary attempt to re-establish high prices after the coal strike. Northamptonshire forge is now obtainable at £14 15s., and foundry at £5 5s. Derbyshire forge is this week quoted £4 15s. to £4 17s. 6d., and foundry at £5 2s. 6d. f.o.t. The demand is very poor, and the furnaces are competing very keenly for business. Some of the foundries still have rather large stocks of pig iron on hand, thanks mainly to the coal strike, and as some of this material was bought when prices were at least £5 above those now prevailing, rather heavy losses have been sustained. Current prices have become so low as to deprive continental material of any competitive advantage, and deliveries are almost entirely restricted to old contracts. The price of fuel and the high railway rates prevent the re-starting of more furnaces while the furnace owner speaks rather dolefully of the losses involved on current sales, which are said to amount to £1 10s. per ton. However, there is little business being done in foundry material and practically none in forge. The production of cold blast iron has been resumed in the Black Country, a Netherton furnace having recently been put into commission after a long spell of inaction. Pig iron production, according to the latest returns, shows an increase from 94,000 tons in August to 235,000 tons in October. This compares with 667,000 tons, the monthly average of last year. At present there are only eighty-two blast-furnaces in operation, compared with 300 a year ago.

Increased Wire Values.

While on every hand values continue to decline, makers of wire nails have raised their basis by £1 to £19 10s. The former price of £18 10s. was not regarded as remunerative, but while foreign competition was acute revision was not possible, nor, indeed, desirable. Now German and Belgian competition has to a great extent disappeared, makers are experiencing a very steady flow of orders, and have felt justified in adding £1 a ton for 2-ton lots. Nor are foreign quotations offered for wire rods, for which at one time the German quoted £8 5s. at port of embarkation. The last Belgian quotation, some months ago, was £11, but the tendency for most Belgian products since then has been to harden. The current English quotations are £12 to £14, the latter figure for high carbon rods.

Continental versus Black Country Mills.

Mr. L. G. Harris, of Messrs. Guest, Keen and Nettlefold, Birmingham, in an informative paper to the Staffordshire Iron and Steel Institute on Saturday last, showed how, with modern plant and methods, Belgium was lowering her production costs and beating Black Country mill owners in the race for business. For a considerable time now Belgian wrought iron manufacturers have been sending bars into our markets at anything from £3 to £4 per ton cheaper than they could be produced in this country. His object was to show by comparison in working methods a few of the causes of this cheaper production. Comparative British and Belgian methods of guide rolling and general forge practice, therefore, formed the subject of his paper, and having dealt technically with the methods which he saw adopted during a visit to Belgium early in 1920, the essayist compared the relative cost of piles for the furnaces, concluding that there was a difference of £3 15s. per ton in favour of the Belgian material ready to charge into the furnaces. Turning to the question of output, he said that taking the average guide mill in the Black Country the output on, say, ¾in. round iron for an eight-hour shift would not exceed 10 to 12 tons, or on ¾in. round iron, 14 to 15 tons average. That, of course, was with, say, two coal-fired furnaces or one large gas-fired reversing furnace. Comparing this with the mill at the first Belgian works he visited, with its three gas furnaces and an output of from 28 to 30 tons of ¾in. round, it was apparent that even after due allowance had been made for extra fuel, labour and plant, the Belgians would still have a considerable margin in increased outputs, which, in turn, reduced their overhead charges and cost of production. As regarded piling, the methods adopted for producing bolt and nut qualities were much cheaper than those generally in vogue in this country. Another very important point in relation to the cost of production was that in the majority of plants in Belgium the general principle seemed to be to lay their mills down with the view of rolling either all steel or all iron, while the weighing up and stocking of the finished bars was most methodical and above anything he had seen in this country. There was no doubt, he said, that at present the continental mills were beating us not only in our own home markets but in every market in Europe.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel and Metals.

ALTHOUGH one hears from time to time of slight improvements in trade in different parts of the country, there is no indication of any such hopeful feeling here, and most people on the Manchester Exchange maintain that matters are worse now than they have ever been. Some interest has been excited here by the report that the Manchester Corporation had decided to construct the new water pipe from Thirlmere of steel and not of cast iron, the tube to be made from steel sheets welded by the acetylene process, and that the quantity of sheets required was 17,000 tons. The great Derbyshire pipe foundries will, of course, be disappointed by this new departure, but the steel manufacturers who are short of orders will be satisfied. Some anxiety is felt here as to the effect which the stoppage of naval shipbuilding will have upon the iron trade. Some hopes of the beginning of a revival were built upon the construction of the four new warships, and there does not seem to be any chance of transferring the work to the commercial shipbuilding trade. That is not likely to revive for a year or two.

Metals.

The market for copper here remains in much the same moribund condition. There is very little local inquiry, and people seek what comfort they can get from reports of improvement in America, and the persistent demand from Germany; but, of course, the latter only means that the German makers of machinery are getting a bigger share of the world demand for all engineering work. It may be satisfactory to the copper producer that Germany is taking metal, but it cannot be an advantage to the British engineering industry. We need to see a revival in the demand for copper in our own engineering circles. There has been no change as yet in the official prices for manufactured copper and brass, and no attempt to modify the anomalies in the various quotations, as, for instance, that brazed brass tubes are dearer than brazed copper tubes, or that 4ft. by 2ft. brass sheets are quoted at 11s. 4d. per pound (£105 per ton) and strong copper sheets at £101. The price of best selected ingot copper remains at only a fraction above standard; but electrolytic keeps up. The low price of best select, of course, reflects the state of the demand for the metal in this country. The American position is thought to be stronger, as the surplus stocks of copper held there are getting smaller. There seems to be an idea that the time to buy copper is coming nearer, and it is probable that the market will pay for watching. Tin also shows some sign of improving, and there is a growing belief that the lowest prices have now been seen. There is, of course, quite a large stock of tin here and there is plenty yet to be sold in the East, but the demand is steady, and more is now being used in the tin-plate trade, which shows some sign of expansion. Cheaper steel has made a great difference to this industry. The demand from America is said not to be quite so good as it was, but that is attributed to the rise in the exchange, which makes tin appear dearer to the American consumer. The market for lead still keeps very strong, and the price has been again a little higher than before. The failure of Australia to resume her proper place in the supply of lead to the world is probably the main reason why this metal does not fall to a level corresponding to the general metal market. Spanish lead is now going freely to Belgium, Germany, and Holland, and hence our receipts of this lead are small. In the spelter market there has been no change and the demand remains quiet.

Pig Iron.

Very little interest is taken here now in the foundry iron market. Buyers no more believe in the prices now they are at £5 10s. than they did when the quotation stood at £7. They were told then, as they are told now, that the price did not pay the producer, and that pig iron was being sold at a loss; but they do not accept that as a reason why the price should not come lower, and any buying of foundry iron which takes place here is strictly from hand to mouth. Probably confidence in pig iron prices and their stability cannot be regained until the various anomalies in the market are removed. Thus it has been an axiom in the trade that Cleveland No. 3 should be the cheapest foundry iron made in Great Britain, but now Cleveland is dearer than Derbyshire, and No. 3 foundry is almost as dear as hematite. There is a report that the railway rates on fuel are to be reduced, but if the reduction is to be no more than that already made on ores and limestone it will not make much difference; although, of course, "every little helps." What Manchester requires is a heavy reduction on the transport of pig iron and of iron castings. The big transport charges tend to cut her off from Scotland, Wales, and the East Coast, and her business opportunities suffer accordingly.

Finished Steel.

In the sectional steel market there is no apparent change this week. The orders given out are comparatively small, although the steel works hope to get a share of the 17,000-ton order for plates to be given out by the Manchester Corporation. The Welsh works—or some of them—continue to quote below the official prices fixed here, but one does not yet hear that the liberty given to the Scotch works to quote what price they like has had much effect. Continental prices for steel remain much as they were.

Scrap.

The market for scrap keeps very dull and quiet. There is no further change in wrought iron or steel scrap and very little inquiry for them, but foundry scrap is easier. One has heard of a lot of common cast scrap being offered below £4, but this seems exceptional. The prices seem to range from £4 10s. to £5, with perhaps a little more than the latter for very fine lots of broken textile machinery.

The Engineering Trades.

Although not so uniformly depressing as they have recently been, the reports which I receive from firms in this district in the various branches of the local engineering trade are not very inspiring. In some directions there seems to have been a slight but none the less perceptible improvement. Inquiries have increased and the head of one well-known firm which produces articles in more or less general use amongst engineers informs me that the number of orders he has received is more encouraging. I fear, however, that whatever improvement there is, is chiefly in connection with the home markets. This is probably due in some measure to the settlement of the wages question, and it is to be hoped that the reduction of the bank rate from 6½ per cent. to 5 per cent. will have a further beneficial effect. Machine tool builders remain still very badly off for work, and there is a steady reduction in the number of persons employed in this branch. Builders of machine tools complain bitterly with regard to the probable effect which the sales of the Government Disposals Board will have on the trade. One prominent machine tool builder informed me a few days ago that brand new tools were being sold at scrap prices and he questions whether it is a good policy with the present conditions of employment to throw these machines on the market with work so badly needed; on the other hand, some engineers argue that it is better to get this state of things cleared off completely at once rather than to have it persisting for an indefinite time. But after all, it is on the foreign trade that the engineering industry is chiefly dependent, and one can see little chance of improvement in this direction with the foreign exchanges dead against this country.

Wages in Germany.

Speaking on this subject the other evening at a meeting of the North-West Centre of the Institution of Electrical Engineers, the Lord Mayor, Mr. E. D. Simon, gave some of his experiences recently in Germany. He said that wages of the skilled engineers in that country were equivalent to 5d. per hour two months ago, whereas they were now something like 3d. per hour. Here the corresponding wages were about 1s. 6d. per hour. With Germany's other advantage of the convenience of raw material, he said it was possible to manufacture machinery in Germany at a quarter the price at which it was manufactured here. He said there was no unemployment in Germany to-day; that practically all the orders from foreign countries were going there; and that there was no hope of English industry being able to meet that competition merely by cutting wages. The only method was to do away with the unfairness of competition—perhaps by getting the mark stabilised. He suggested that industrial organisations should study this matter and advise the politicians and see that proper remedies were applied.

The Cotton Trade.

It is particularly unfortunate, too, at this juncture that the cotton trade, which a few months ago showed signs of improvement, is relapsing again. The Committee of the Cotton Spinners' Federation has gone so far as to recommend that the operatives of spinning mills using American cotton should only be employed three days a week for the remainder of the year, a step which will be the means of further swelling the ranks of the unemployed. What that means can be gathered from the figures given by the Labour Ministry of the north-western area for the week ended November 11th. The total number of unemployed men and women as shown by the live register at that date was 284,044, an increase of 18,300 on the previous week. The number of current claims to uninsured benefit on the same date from all the unemployed persons was 278,107, and from short-time workers 650,053. This change for the worse is mainly due to the state of the textile industry.

BARROW-IN-FURNESS, Thursday.

Hematites.

The position in the hematite pig iron trade of this district has undergone no change during the past week, certainly no change for the better. The recent cut in prices has not yet resulted in an increased amount of business, for buyers are not anxious to order more than will cover their immediate wants. Locally a fair tonnage is going into use at the steel works, and a little is going away by rail and sea, but the total production remains limited, and according to present prospects an improvement is not likely this year, and it may be next spring before there is a step forward of any moment. There will naturally be an easing off in the demand on the part of steel makers interested in the making of shipbuilding material. Already a furnace has been damped down at Ulverston. Prices remain unchanged on the recent reduction.

Iron Ore.

For iron ore there is a moderate demand. The trade is almost wholly a local one, with now and again a shipment coastwise. At the mines there is marked quietness, with short time at the pits working, whilst many mines are quite idle. Spanish ore is being imported into Barrow at the rate of about a cargo per week.

Steel.

The steel trade presents no new features. The demand all round is very quiet. Rails and hoops have been occupying most of the attention, hoops being rolled from French billets. The foundries are moderately employed.

Shipbuilding and Engineering.

The suspension of the Admiralty orders at Barrow has caused considerable depression, where increased activity had been looked for in the immediate future. Merchant work is gradually being completed and no new orders are coming to hand. The outlook in these trades is poor.

Fuel.

For coal there is only a moderate demand, and coke, nearly wholly of the East Coast variety, is in poor demand.

SHEFFIELD.

(From our own Correspondent.)

Industrial Coal Prices Falling.

PRICES of manufacturing fuels continue on the down grade, and as far as quotations for large steams, given in the list of "current prices," are concerned, at all events, they represent the very maximum figures for inland sales. For spot lots from stocks it is possible to buy at substantially lower rates. Collieries are taking orders for shipment *viâ* the Humber ports at exceptionally low values—below the minimum inland prices, as I was able to show and to explain a week or so ago. What is quite anticipated is that the prevailing competitive atmosphere will have the effect of forcing prices down still further and shortening the margin between similar qualities of

coal. At the moment, however, it is no unusual thing for practically identical fuels to be quoted at as much as from 5s. to 6s. per ton difference in pithead prices. Owing to the recently reduced outputs in consequence of short time working and the larger usage for coke-making purposes, the market for small fuels is steady and there is no forced selling noticeable at the moment. Best grades of household fuel are in active demand, but second qualities are moving somewhat slowly, a considerable weight of manufacturing fuels having been thrown on to the house coal market. With the larger production, the demand for coke is somewhat weaker, particularly as the call for export is not as active as recently. Reference to the "current prices" list, under Sheffield, will reveal the fact that Yorkshire and Derbyshire hards, as well as seconds, cobbles and nuts, amongst "steams," have fallen between 5s. and 6s. a ton, that blast-furnace coke is about 3s. a ton lower, being now from 25s. to 30s. a ton at ovens, and that house coals have been slightly reduced. This downward tendency of the fuel market is one of the most hopeful features of the situation, and is already leading to a renewal of activity among consumers. My readers will, perhaps, kindly note the new coal and coke prices.

Black Smoke.

Sheffield's chief smoke inspector, under the municipality, has just been giving some very interesting figures regarding the old subject of the unnecessary belching of black smoke from the various works. It may seem to most people a not particularly opportune moment to discuss such a matter, because in passing through the heavy works portion of the city the thing that distresses one most at the moment is the absence rather than the presence of smoke in the atmosphere. The latter, as conditions are, is much too clear to be industrially healthy, though the contention of Mr. Nicholson and of those ardent spirits who labour to bring forth a purified atmosphere for the whole of Sheffield—to eliminate the smoke pall which hangs permanently over the city in normal times—is that their aim could easily be achieved if every one concerned would help. I am not going into the argument now, but it is well known that some of the Sheffield steel makers and forgers have a very deeply rooted opinion that the thick wreaths of smoke which so vex the soul of the reformer are blessings in disguise for those engaged in certain departments of steel manufacture, and that unconsciously the atmosphere reformers are killing the smoke that spreads a golden cloud, so to speak. Nevertheless, the chief inspector made some good points. Under the prevailing system, he asserted, 80,000,000 tons of the 240,000,000 tons of coal consumed annually are wasted by being discharged into the air—really worse than wasted. "It means that from 400 to 700 tons annually of solid matter were deposited on every square mile, poisoning the air people must breathe, shutting out 40 per cent. of life-giving sunshine, becoming responsible for 30 per cent. of our fogs, destroying vegetable life, disfiguring and doing irreparable damage to property, incalculable injury to health, and increasing mortality, especially infantile."

Sheffield's Old Nickname.

In 1888, he added, Sheffield was rightly called "Hell with the lid off," for its forest of works' chimneys poured out day and night smoke, flame and sulphur, some for 40, some for 50, and some for 60 minutes to the hour. When the matter was taken up by the Corporation in 1890 it was found that one boiler need not make more than two minutes' black smoke per hour, two boilers three minutes, three boilers four minutes, and four or more boilers six minutes. Manufacturers spent much money in providing more boiler power, mechanical stokers, forced, induced and balanced draught, hollow bridges, patent bars and many other devices to assist the stoker in the prevention of black smoke and the saving of coal, with the result that nowadays, under normal working conditions, there is a reduction of the average emissions of black smoke per chimney per hour of from 30 minutes to three minutes. Even to-day, however, the smoke nuisance is costing the country at least £200,000,000 a year. I was discussing this very question one day with Mr. Charles E. Siddall, the chairman and managing director of the Sheffield Forge and Rolling Mills Company, Limited, of Millsands—the site of the works originally founded by the Vickers family—and he laughingly declared he had lived in the poisonous atmosphere all his life and seemed little the worse for it. Few men have done more in Sheffield toward purifying the air, for his rolling mills are electrically driven, and every other modern innovation has been introduced at Millsands, but one of his pet aversions is the sight of a smoke inspector trying to catch him napping. By the way, "Charlie Siddall," as he is called by his intimates, has just completed his fortieth year with the Sheffield Forge concern, the bulk of which time has been spent in one official position or another, until to-day "Charlie Siddall" and the "Sheffield Forge" almost seem to be synonymous terms. He appeared at Millsands first as an office boy, and has shown wonderful ability in building the company up on a sound financial basis, whilst at the same time developing and modernising the plant and machinery. It was not in the Sheffield Forge office, however, that he laid the foundation of his knowledge of finance. I know where he got it, because he has sometimes chatted with me about his pre-Millsands days, but whether he would expect me to repeat the story here I am not so certain. One thing I can say, however, and that is that it was all to his credit. Mr. Siddall has a way with him that greatly endears him to his workpeople as well as to colleagues, and it was this feeling, no doubt, that was responsible, a few days ago, for a little dinner party in his honour at which his co-directors and the staff presented him with a silver scroll, beautifully mounted and engraved with the facsimile signatures of the various members of his staff at the works.

Gas for Furnaces.

Since my previous letter, in which, it may be remembered, reference was made to the fact that the Gas Company has decided to reduce the price of Sheffield gas as from New Year's Day, a manufacturer here, very well known in steel circles, has been unbosoming himself on the subject. Let me quote his words: "I have twelve gas engines, and am perhaps more dependent on gas than any other firm. I cannot carry on my works without gas—and cheap gas. I have been running five engines. In 1916 those engines consumed 16,600 cubic feet of gas per day at 10d. per cubic foot. Working ten shifts a week, the cost of gas was then £1604 per year. On account of the bad quality of the gas we are to-day using 17,600 cubic feet per day, at the very least, and the charge up to March 31st last was 3s. 2d. per 1000, nearly four times as much as in 1916. Early this year the Gas Company commenced its system of charges per therm, which has worked out at the rate of 3s. 8d. per 1000, or a further increase of 6d. per 1000, bringing my account up to over £8020 per annum, or an increase of £6416 on the amount paid five years ago." That was a plain statement, and the effect of the increased cost is that the manufacturer has had to shut down the greater part of his works, for his customers are getting all they want from Belgium, the cost of gas preventing him from trying to supply them, whereas with reasonable rates in operation he could keep orders and work in Sheffield. Yet, I may add, it is a fact that Sheffield is being supplied at a lower rate than prevails at places like Leeds and Bradford. The manufacturer contends that the Gas Company is sending out a poorer quality gas and charging 500 per cent. more for it.

General Conditions.

Regarding the naval contracts, which continue to hold their place as the main topic for armament circles here, I find a disposition to "wait and see" a little longer before concluding that suspension of work on the four battle-cruisers actually means abandonment of the programme. As one highly placed official pointed out to me the other day, agreement in principle with the Washington proposals may prove to be a very different matter from blindly following America's scrapping suggestions. In any event, it is urged that matters already have proceeded so far with the contracts that in case the new building should be definitely thrown over the firms concerned would have to be compensated on a pretty considerable scale. In some cases the mere putting of the armour plate making shops into proper working order has involved great expense. In the meantime the incident has undoubtedly put a damper on the spirits of large numbers of men who had good hopes of returning to work, after months of unemployment, if not before Christmas, immediately afterwards. Apart from that consideration, however, it must be admitted that a more optimistic spirit is revealing itself. The loans being placed in this country by Australia, South Africa and India (not long ago) are taken as clear indications that those countries have some good orders to place in the home markets, and whilst financial conditions in China and the unstable political situation there are retarding trade with the Celestials, from other parts of the East the buying movement is springing up and gathering strength. The small "boomlet" in the motor trade is regarded with very great satisfaction in this district, where many of the firms are regular suppliers of the steel and parts required in automobile construction. The European markets are still not very responsive, and, taken on the whole, export business continues very poor indeed. Even where expansion is shown either in the home or oversea market, orders seem to be for quite small quantities, and manufacturers long for a return to a state of things when business can be put through on mass production lines, for, generally speaking, their output capacity is very considerably greater than in pre-war days. Agricultural engineers are experiencing very little, if any, recovery from the heavy slump in that important department of industry, and rolling stock builders are only doing fairly well, a new type of Pullman being under construction at the Clayton Wagon Works, Lincoln, and a series of restaurant and sleeping cars is being built for Siam by Cravens, of Darnall, which firm has had a good deal of other work in hand of late, including tank wagons. Edgar Allens have recently completed for Sweden what is claimed to be one of the largest lay-outs in manganese steel constructed in this country, and the same firm has completed the largest rock crushers of the gyratory type ever made in this country. It is intended for reducing huge blocks of hard chalk to the proportions of small cubes. Russia is doing a nice bit of buying in Sheffield, chiefly of files and tools, and notable strides are being made with the development of the new material, rustless iron, two more firms—Osborn's and Saville's—have recently placed a metal of this kind on the market. The correct name for this rustless ductile material is still being sought. I notice that Samuel Osborn and Co. call their product "Rustless Plastic *Steel*," which is probably more nearly right than "rustless *iron*." Iron and steel keeps on the downward tendency, though the movement is, happily, a gradual one.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Situation.

The week has been an uneventful one for trade in the North of England. Certainly the position has not improved, and the fact that at one of the largest iron and steel works in the district a considerable reduction in the number of employees, if not an actual stoppage for an indefinite period, is possible, does not encourage the hope for that revival which was expected after the drastic cut in iron and steel prices.

Cleveland Iron Trade.

The position of the Cleveland pig iron trade has undergone little material change during the week. It was generally expected that a further reduction in prices would be made, but it has not materialised. The fact is that the ironmasters—already selling at a loss—have reached the limit of sacrifice, and it is felt that the railway companies and the coke makers should take a share of the burden involved in re-starting industry. The pig iron-makers have done their share, but are crippled by high railway charges. Given reasonable transport charges, they are confident that they can meet foreign competition, but the present high rates keep them out of the business. Buyers seem determined to hold off until some measure of stability has been restored to the market, and of that there is no present indication. There is still a wide disparity between Cleveland and continental iron prices, quite good foundry iron being offered from abroad at 87s. 6d. per ton c.i.f., compared with 110s. for No. 3 Cleveland. Moreover, Derbyshire No. 3 is being offered at 105s., and mixed numbers of East Coast hematite, usually a few shillings more than No. 3 Cleveland, is now being offered at the same price, viz., 110s. There is thus good ground for the opinion that a further cut in prices cannot be long delayed, but it is entirely contingent upon the action of the railway companies. There has been a slightly better inquiry, but even yet the output of three blast-furnaces seems to be sufficient to meet all the requirements for Cleveland foundry iron, although it is indicated as a probability that two more furnaces may shortly be diverted from basic to foundry iron production. Even then, however, there would only be five furnaces on foundry iron, as against a normal of twenty-two to twenty-four. One concession has been made as to prices, the loading charge of 2s. 6d. per ton for placing iron f.o.b. having been abolished. This, no doubt, will assist towards reviving the Scottish trade, but there is still a gap to be bridged before Cleveland can compete with the foreigner in the Scottish market. With this modification the prices of Cleveland iron remain at 115s. for No. 1, 110s. for No. 3, 105s. for No. 4 foundry, and 100s. for No. 4 forge, with mottled and white nominal at 97s. 6d. and 95s. per ton respectively.

Hematite Pig Iron.

A much weaker tone has developed in the East Coast hematite pig iron trade. Keen competition for orders has further depressed the price, and it is now possible to buy mixed numbers at 110s., with No. 1 2s. 6d more. It is the cheapest hematite in the country, and South Wales, where the steel trade is brisk, is taking fair quantities. Italy, too, is buying again, although only sparingly, but Sheffield is practically out of the market, and the demand generally is not large.

Iron-making Materials.

The price of pig iron is falling so rapidly that, although medium furnace coke is now offered freely at 30s. per ton delivered at the works, the ironmasters find the price of fuel beyond their means, and they insist that coke must fall still further before they can re-start the idle furnaces. Meanwhile most of the coke ovens are also idle, and coke makers seek in vain for orders. An occasional odd transaction is reported in foreign ore, but the total tonnage involved is quite trivial, and there is still no real expansion or indeed any sign of an expansion of business. Prices show no sign of any further decline, and best Rubio ore seems fairly steady at 27s. per ton c.i.f.

Manufactured Iron and Steel.

The manufactured iron and steel trade in the North of England is in a very depressed condition. In every branch of the trade business seems to be at a very low ebb, and there seems not much hope of any revival until the turn of the year at least. It has indeed become a question whether the works can carry on until then, and it is certain that there will be a prolonged holiday stoppage. Prices are unchanged simply because makers are already selling at a loss, and can scarcely afford to make further sacrifices. Nevertheless, whilst adhering to the price agreements for the home trade, makers are actually quoting as much as 30s. per ton less for export orders, and even so find it difficult to get business.

The Coal Trade.

The general position of the northern coal trade shows a slight improvement as compared with what it was a week ago. This is especially the case so far as the Northumberland coalfield is concerned. In the Durham area, however, the position resolves itself in many cases into dragging along from day to day, with a struggle on the part of many collieries to keep working a few days each week, some being forced to lie idle for the greater part of each week. The export trade continues quiet, inquiries being of insignificant dimensions just now, in only odd cases resulting in actual business, notwithstanding the exceptionally low quotations. The home trade is not expanding to anything like the extent anticipated. The improvement in the steam coal market is fully upheld, and as a rule the Northumberland collieries are more or less comfortably situated as regards bookings for the early part of next month, which is due not only to the approach of winter, but also to the shorter number of working days in December. Inquiries for steams are slightly fuller, and if the quotations now going forward from time to time can be kept at something like competitive figures there should be a big improvement in the turnover in the near future. The Durham market is very erratic and patchy in respect of all classes of gas coal, and though prices of the best brands remain at the moment unaltered, there is reason for anticipating that even lower values may be recorded in the next few days. Supplies of bunkers are plentiful, and bargains can be secured where a prompt stem is given. The coke position shows little alteration. Gas coke is steady, with most of the production earmarked against home requirements and contracts, though for export there is only a moderate amount of business being done. Foundry and furnace coke is dull and weak.

SCOTLAND.

(From our own Correspondent.)

Steel Trade Crisis.

The withdrawal—or perhaps it should be said the stoppage in the meantime—of the Admiralty contracts is a most serious blow to the steel works in the West of Scotland. Thousands of workers had expected to be at work this week. Works were to be restarted in order to proceed with the steel material required on the new battleships, and that would have compensated in a

measure for the closing down at other works. Now, however, the works in question have to be added to the list of unemployed. As there is no indication of anything in the shape of a good contract to take the place of the suspended work, the situation in the trade is serious.

Shipyards Also.

The position at the shipyards is hardly any better. Certain work is still in progress, but when it is worked off there will be nothing to take its place. Furthermore, word has just come to hand of cancellations of orders for liners and contracts lost to foreign shipbuilders who are quoting figures 20 per cent. lower than local builders. That something on a big scale will have to be done soon is apparent to all; otherwise the shipyards, steel works, &c., will be all closed down.

Cutting of Prices.

It has been suggested that there is a possibility of a price-cutting contest between Scotch and English steel makers. Prices were recently "freed," and the territorial principle abandoned, and producers across the Border are therefore at liberty to quote for delivery in the West of Scotland. Several English firms are said to have already done so, and with some success, as their prices are lower than Scottish quotations. The latter are naturally inclined to lower values, but makers here are convinced that in view of present costs neither side can afford to "cut" its charges. In fact, one prominent Scottish concern in a communication to its workers says that in spite of all recent price reductions nothing tangible has resulted, and no increase in business is noticeable. Furthermore, as the prices quoted are under cost, the managers indicate that the position is becoming impossible, and orders cannot be accepted at a loss much longer. The firm in question has only one mill running at headquarters, while others of its establishments are closed down entirely.

Iron.

The pig iron works naturally share in the general depression. Local consumers cannot afford to pay the price asked, and imported material still gets the preference. Local costs of production will not allow of a substantial fall in prices, as it is said that some makers are already losing on sales. Unless something unforeseen occurs, there is every probability that some of the furnaces will again be damped down. For a long time now bar iron has been comparatively idle, consumers not being in the market at the prices quoted for Scotch material. Makers have now made a cut of 30s. per ton in quotations, and it remains to be seen what will follow. Inquiries have been more generous of late, but the price has been an effective stumbling block.

Coal.

The Scotch coal trade during the past week was devoid of any feature of note, and business was on recent lines. So far as land sales are concerned, smalls are very difficult to dispose of, owing to the industrial depression, while those consumers still in the market are only purchasing from day to day in view of the fluctuations in prices. Cheap rates are occasionally named for prompt business. Large coals are doing fairly well for household consumption, and are moderately well booked for shipment abroad. Treble and double nuts are doing some business for foreign shipment, and prices are fairly steady, but singles and small stuffs are weak. Overseas shipments from Clyde ports bulked rather better. Aggregate clearances amounted to 200,366 tons, against 184,141 tons in the preceding week and 280,122 tons in the same week in 1913.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

It is quite a change from past experience to be able to record that there is a steadier tone in the coal trade, and that although it would be going too far to say that the conditions are distinctly improved, still it is possible to say that there is more activity. Firms individually are perhaps not feeling the effect very much, but it must be remembered that there are more exporting firms in existence to-day—just as there are more importing firms abroad—many of whom albeit know very little about the coal trade, and consequently take more risks than those who have been in the business for years. Evidence that the conditions are not as bad as they have been is to be fonnd in the fact that collieries are working more regularly; less is heard of pits having to stop operations for the want of empty wagons, although that trouble is not, of course, by any means eliminated. Furthermore, colliery salesmen are not making the concessions in prices that they were forced to recently, and they are standing up to the bearing tactics of buyers with much more determination and success. It is not to be supposed that the prices of South Wales steam coals have touched bottom, as it cannot be said that they are yet on a real competitive footing with North Country coals. There is still too great a disparity between them to the disadvantage of this district, and, in addition, South Wales is handicapped by the heavy railway and dock charges, which unfortunately do not look as if they are to be reduced anything like as soon as it was hoped would be the case. In spite, however, of all the difficulties, business is a shade better for prompt loading, but there is no manifest disposition for buyers abroad to come along with purchases over a long period. The chartering of tonnage has recently been on a more active scale, and rates have advanced to some extent, much to the satisfaction of shipowners who are still having a rather bad time, and are lucky if they can make both ends meet. But this spurt in chartering and improvement in rates may have caused an impression that the coal business was beginning to go ahead with unexpected vigour. It is as well, however, to be not too optimistic, while fully recognising that there seems to be a gradual expansion, as other factors have contributed to the advance in freight rates. These factors are that owing to bad weather, tonnage has got out of position, with the result that merchants have had to come on the market to pick up prompt supplies, and, furthermore, it is undoubtedly the fact that steamers of the larger types are getting more distributed as the world trade gradually settles down.

Miners' Quandary.

Reference was made last week to the restiveness of the miners on account of their low earnings, more particularly as regards the lower-paid day wage men, and the efforts of their leaders to persuade the coalowners to grant them allowances. After the meeting of the Joint District Board, the Executive Council of the Federation assembled to consider the position in view of the warning from the employers that the granting of allowances would mean increasing costs to the probable disadvantage of the trade. Furthermore, the members had to admit that they were in a quandary, as in the event of their taking advantage of the provision in the general wage rate agreement for raising the rates of the lower-paid workmen, this would have to be borne by the whole of the workmen in so far as 83 per cent. of the costs are concerned. It will therefore be seen that the leaders displayed some hesitation to press their application upon the coalowners, but they decided to call another meeting of the Joint Coal Board with a view to making proposals to the owners, and to hold a coalfield delegate conference at Cardiff next Saturday, when the result of the negotiations could be reported and the situation could be discussed. At the moment of writing it is not known what took place at the Joint Coal Board meeting, at which it was the intention of the miners' representatives to raise several points, including complaints regarding alleged non-observance by the owners of the terms of the Minimum Wage Act, and interference with established customs and practices. The workmen at North's Navigation and Celtic collieries who had threatened to hand in fourteen days' notices on account of their grievances respecting minimum wage claims, are withholding them in view of the coalfield delegate conference on Saturday.

Coalowner Faces the Men.

During the past few weeks several of the colliery managements have threatened their workmen that the pits would be closed if the workmen did not put forth better efforts and turn out a larger supply of coal, and thus reduce working costs, but Mr. W. North Lewis, the chairman of the Windsor Steam Coal Collieries, took the lead on Sunday last in addressing his workmen, instead of leaving it to his management to deal with this question. Mr. Lewis put all the cards on the table, and appealed to the workmen to co-operate with them, as at the present rate of working and at the present cost, they could not hope to continue for any considerable length of time. He suggested that the men should start work earlier in the morning to get some coal out in the early hours and that they should fill cleaner coal, and while expressing the view that the prospects of trade were brighter than they had been for months, said his "tonic" for the coal trade was the suspension of the Seven Hours Act. Apparently his "tonic," however, did not meet with the approval of his audience; but at any rate the miners' leaders who were present assured Mr. Lewis that the men would endeavour to improve the output.

Hugo Stinnes and Welsh Coal.

The recent visit of Hugo Stinnes, the German coal and iron magnate, to this country has revived rumours of his intended renewal of activities in Welsh coals. In fact, it is stated that he has been responsible, through intermediaries, for considerable shipments effected of late to the Mediterranean. In pre-war days Hugo Stinnes was very closely associated with the South Wales coal export trade, and was represented at Cardiff and other centres, and, as is well known, he controlled a depôt of his own at Messina. It is doubtful whether sentiment will play any large part so far as business is concerned, seeing the condition in which the mining industry is placed, and it is unlikely that the question for whom or for what destination will be raised, provided owners can find an outlet for their product. It is, in fact, reported that before so very long one of the largest German coaling firms will be opening at Cardiff.

Tin-plate Trade.

The outlook is regarded as brighter, and at Llanelly the position in respect to unemployment has improved. Orders are reported to be coming along steadily. The Western Tin-plate Works restarted on Monday, and last week the eight-hour shift was reverted to at Messrs. Richard Thomas and Co.'s South Wales mills, this company having secured the order for 150,000 boxes for British Columbia. According to Mr. H. Coulson Bond, of Messrs. Richard Thomas and Co., there will be a steady increase in the demand for tin-plate from now onwards, and whether South Wales will take a larger or smaller share of that increase depends upon her costs of production. As showing how the problem had been tackled by everyone connected with the industry, he states that it is costing to-day about one-half what it cost nine months ago to produce a box of tin-plate.

Current Business.

The market for prompt supplies of coal does not exhibit the pronounced weakness that has been the case recently, although it cannot be said that it is devoid of weak spots. The docks are busier and loading berths are not so easy to obtain. There has not been the fall in values such as have had to be recorded weekly, and colliery salesmen are adhering to their quotations more firmly.

Latest News from the Provinces.

SHEFFIELD.

Bar Iron Reduced Again.

The South Yorkshire Bar Iron Association has reduced the basis price for Crown bars by 30s. from £14 10s. to £13 per ton net delivered in the Association's area.

NORTH OF ENGLAND.

Big Contract for Bridges.

In face of strong foreign competition, the Cleveland Bridge and Engineering Company, of Darlington, has secured contracts from the Union Public Works Department, South Africa, for the steel work of no fewer than twenty bridges. The weight of the forty-five spans required will be approximately 4400 tons, and the cost £200,000. The contract was obtained in open competition against leading firms in Britain, France, Belgium, Canada and the United States.

Large French Coal Order for Durham.

The Chemin de Fer du Nord of France has purchased from 30,000 to 50,000 tons of Durham unscreened and coking coals for delivery over the most or whole of next year. The price has not been disclosed, but as the contract has been fixed on a basis of payment in francs, the price in English money will vary as the exchange rates rise or fall.

WALES AND ADJOINING COUNTIES.

Miners' Grievances.

The Joint Coal Board has agreed to the appointment of a sub-committee to draft a scheme relative to the miners' application that lower-paid men be granted allowances so that the minimum earnings should be 7s. 8d. per day, this scheme to be submitted to another special meeting of the Board on Tuesday. The owners have also undertaken to prepare a memorandum to be issued to colliery managements regarding the complaints of alleged non-observance of the Minimum Wage Act. The men were reminded that they also had obligations as well as rights. In view of the decisions come to, the delegate conference of miners called for Saturday has been postponed until Saturday week.

Swansea Metal Exchange.

The tone is more cheerful regarding the tin-plate outlook. There are now over 70 per cent. of the mills working, and business has been done for India, Holland, Spain, France, Portugal, Mexico, Central America, and the Argentine, the business for the latter countries being in the face of American competition. The associated price for tin and sheet bars is £7 15s. per ton delivered, but outside works quote down to £7 5s. per ton delivered. The market for galvanised sheets is rather easier notwithstanding a slightly better inquiry.

LAUNCHES AND TRIAL TRIPS.

San Fabian, oil tank steamer; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Eagle Oil Transport Company; dimensions, 547ft. by 69ft. 4in. by 42ft. 3in. Engines constructed by Wallsend Slipway and Engineering Company, Limited; launch, Tuesday, October 18th.

Kutsang, passenger and general cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of Indo-China Steam Navigation Company; dimensions, 434ft. by 54ft. by 31ft.; to carry 7000 tons deadweight. Engines, four-cylinder quadruple-expansion, pressure 220 lb.; constructed by Wallsend Slipway and Engineering Company; launch, Wednesday, October 19th.

Single-screw oil tanker; built by the Monmouth Shipbuilding Company, Limited; dimensions, 331ft. by 46ft. by 25ft. 6in.; to carry 5000 tons deadweight. Engines, triple-expansion; constructed by Fairfield's Shipbuilding and Engineering Company, Limited; launch, Wednesday, October 19th.

Sir George Lloyd, cutter suction pump reclamation dredger; built by Wm. Simons and Co., Limited, to the order of High Commissioner for India. Engines, two sets compound surface condensing, pressure 180 lb.; constructed by the builders launch, Friday, October 21st.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Major F. T. Wright, A.M.I. Mech. E., A.M.I.E.E., who recently resigned from the Siamese State Railways, has been appointed Electrical Engineer to the Bombay, Baroda and Central India Railway, and expects to leave for India shortly.

W. H. Allen, Sons and Co., Limited, have secured from Harland and Wolff, Limited, a licence to manufacture Diesel engines under the Burmeister and Wain patents. The engines will be designed especially for electric generating and auxiliary plants in ships.

The Anti-Attrition Metal Company, Limited, the works of which are in Glengall-road, London, S.E. 15, has closed its city offices, which were at Cornwall Buildings, 35, Queen Victoria-street, and opened other offices at 1, Victoria-street, Westminster, S.W. 1.

We are advised that Major N. Maas, B.Sc. (Eng)., M.I.N.A., A.M.Inst.C.E., has recently joined Mr. A. T. Wall as a partner in the business of Consulting Naval Architects and Engineers. The present title of the firm is A. T. Wall, Maas and Company, and it has recently moved into new offices at 310, Royal Liver Building, Liverpool.

EDUCATIONAL INTELLIGENCE.

The Committee of University College, London, has awarded Goldsmid Entrance Engineering Scholarships of the value of £20 each, tenable for three years, to Mr. H. J. Channon, Mr. P. Hall, and Mr. H. Kaufmann, on the results of the scholarship examination held in September.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	6 10 0	—
No. 1 Foundry	6 12 6	—
No. 3 ,,	6 7 6	—
N.E. Coast—		
Hematite Mixed Nos.	5 10 0	5 10 0
No. 1	5 12 6	5 12 6
Cleveland—		
No. 1	5 15 0	6 0 0
Silicious Iron	—	—
No. 3 G.M.B.	5 10 0	5 15 0
No. 4 Foundry	5 5 0	5 5 0
No. 4 Forge	5 0 0	5 0 0
Mottled	4 17 6	4 17 6
White	4 17 6	4 17 6
Midlands.		
Staffs.—		
All-mine (Cold Blast)	17 0 0 to 17 7 6	
Part Mine Forge	*None offering.*	
,, Foundry No. 3	*None offering.*	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 17 6 to 5 0 0	
,, Forge	4 12 6	—
(3) Derbyshire—		
No. 3 Foundry	5 2 6	
Forge	4 17 6	
Lincolnshire—		
Basic	*Uncertain.*	
Foundry	,,	
Forge	,,	
(4) N.W. Coast—		
N. Lancs. and Cumb.		
Hematite Mixed Nos.	6 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best ,,	17 0 0	—
N.E. Coast—		
Common Bars	14 0 0	—
Marked ,,	18 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	13 0 0	—
Hoops	16 5 0	16 0 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	14 0 0	—
Hoops	17 5 0	—
Midlands—		
Marked Bars (Staffs.)	17 10 0	—
Crown Bars	13 5 0 to 14 10 0	*Nom.*
Nut and Bolt Bars	13 5 0 to 14 10 0	*Nom.*
Gas Tube Strip	15 0 0	—
Hoops	17 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	15 10 0	—
Ship Plates ¾in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ¼in. to ⅜in.	12 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	10 10 0	—
Fish-plates	15 10 0	—
Channels	14 10 0	—
Hard Billets	9 10 0	—
Soft Billets	7 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	11 0 0	—
Light ,,	13 0 0 to 15 0 0	
Billets	9 10 0	—
Ship Plates	10 10 0	—
Boiler ,,	16 0 0	—
Manchester (*Prices irregular and uncertain, unchanged*)—		
(8) Bars (Round)	10 0 0 to 12 0 0	
(8) ,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	
Sheffield—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	10 0 0	—
Soft ,,	8 10 0 to 10 0 0	
Hoops	14 5 0	—
Soft Wire Rods	12 0 0	—
Midlands—		
Small Rolled Bars	10 15 0 to 11 0 0	—
Bessemer Billets and Sheet Bars	8 0 0	
(2) Hoops	13 10 0	—
Tube Strip	11 10 0	—
Sheets (24 W.G.)	15 0 0 to 16 0 0	
Galv. Sheets (f.o.b. L'pool)	18 10 0 to 19 0 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	21/- to 22/6
Block Tin (cash)	£61 10 0
,, (three months)	£63 5 0
Copper (cash)	£68 12 6
,, (three months)	£67 12 6
Spanish Lead (cash)	£24 15 0
,, (three months)	£24 15 0
Spelter (cash)	£25 17 6
,, (three months)	£26 10 0
Manchester—	
(9) Copper, Best Selected Ingots	£69 0 0
(9) ,, Electrolytic	£75 0 0
(10) ,, Strong Sheets	£101 0 0
,, Loco Tubes	£0 1 2½
Brass Loco Tubes	£0 1 0½
,, Condenser	£0 1 4½
Lead, English	£25 15 0
,, Foreign	£24 15 0

(*Metal prices practically unchanged*).

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£28	12/-
,, 6 p.c. to 8 p.c. ,,	£26	10/-
,, 8 p.c. to 10 p.c. ,,	£26	10/-
,, Specially Refined		
Max. 2 p.c. carbon	£79	28/-
,, 1 p.c. ,,	£94	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese (per ton)	£18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	21/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	14/6 per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
,, ,, Ell	26/-
,, ,, Splint	27/6 to 32/6
,, ,, Trebles	24/6
,, ,, Doubles	21/-
,, ,, Singles	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	27/6
,, ,, Trebles	24/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	19/- to 22/6
Screened Navigation	29/6
Trebles	24/-
Doubles	20/6
Singles	18/-
Lothians—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	21/6
Trebles	25/-
Doubles	22/-
Singles	18/-
England.	
(11) N.W. Coast—	
Steams	34/6
Household	40/- to 55/-
Coke	36/6 to 39/6
Northumberland—	
Best Steams	22/6 to 23/-
Second Steams	21/6 to 22/-
Steam Smalls	15/-
Uncrossed	21/6
Household	25/- to 30/-
Durham—	
Best Gas	23/- to 24/-
Second	20/- to 22/-
Household	25/- to 30/-
Foundry Coke	37/6 to 40/-
(12) Sheffield—	
S. Yorks. Best Steam Hards	27/- to 29/-
Derbyshire Hards	26/- to 28/-
Seconds	25/- to 26/-
Cobbles	25/- to 26/-
Nuts	23/- to 24/-
Washed Smalls	17/- to 18/-
Best Hard Slacks	17/6 to 18/6
Seconds ,,	17/- to 17/6
Soft Nutty ,,	17/- to 17/6
Pea ,,	11/6 to 12/6
Small ,,	9/- to 10/-
House, Branch	39/- to 41/-
,, Best Silkstone	37/6 to 39/-
Blast Furnace Coke (Inland and Export)	22/6 to 27/6
Cardiff— (13) South Wales.	
Steam Coals:	
Best Smokeless Large	25/6 to 26/-
Second ,, ,,	25/- to 25/6
Best Dry Large	25/6 to 26/-
Ordinary Dry Large	25/- to 25/6
Best Black Vein Large	24/- to 24/6
Western Valley ,,	23/6 to 24/-
Best Eastern Valley Large	23/6 to 24/-
Ordinary ,, ,,	21/6 to 22/6
Best Steam Smalls	18/6 to 19/-
Ordinary ,,	12/6 to 18/-
Washed Nuts	32/6 to 35/-
No. 3 Rhondda Large	30/- to 31/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	15/- to 16/-
Coke (export)	42/6 to 47/6
Patent Fuel	26/- to 28/6
Pitwood (ex ship)	40/- to 42/6
Swansea—	
Anthracite Coals:	
Best Large	55/- to 57/6
Seconds	52/6 to 55/-
Red Vein	47/6 to 50/-
Big Vein	55/- to 57/6
Machine-made Cobbles	72/6 to 75/-
Nuts	72/6 to 75/-
Beans	58/6 to 60/-
Peas	24/- to 25/-
Breaker Duff	8/- to 8/6
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	28/- to 28/-
Seconds	25/- to 26/-
Smalls	12/6 to 16/-
Cargo Through	20/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. (7) Export Prices—F.O.B. Glasgow. (8) Prices represent the real market before the *official* change was made.
(9) These prices are practically alike now. (10) Sheets reduced while other prices are advancing.
(11) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (12) For inland sales. (13) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

The Aviation Show.

THE remarkably fine exhibition of aeroplanes in the Grand Palais showed that while progress continues to be made in design and construction, it is by no means rapid, and the majority of makers still hesitate to break away from traditions until theories have crystallised into definite formulæ. The International Congress on Aeronautics being held in connection with the Salon, already gives promise of providing the industry with valuable data that will enable manufacturers to follow lines of development likely to give the most satisfactory results. So far as the aeroplanes themselves are concerned, all the elements of progress that seem possible with the existing types of machines were in evidence at the Salon. Whether one or two planes are used is a matter of convenience, and the system which offers the least head resistance and removes obstruction from the view of the pilot and passengers will finally prevail. Every maker aims at suppressing struts and stays wherever possible. This inevitably leads research to the monoplane of sufficiently thick section to dispense with struts and stays. The French have hesitated to follow up this line of development, for the partial abandonment of the monoplane is too recent to inspire confidence in that type of machine; but in Germany the monoplane of thick wing section has been worked out scientifically with excellent results, and a characteristic example of this type was the Fokker, which, by the way, aroused a good deal of hostility among Parisians, to whom the name revived disagreeable memories of the war. Nevertheless, the Fokker represented a successful type constructed on new principles with a thick wing section whereby an increased depression on the upper surface due to the curve augmented the lifting capacity. Such a principle tends to the employment of smaller plane areas, and in the case of the Fokker, the cabin for four passengers and the pilot was suspended directly from the single plane by means of brackets without external struts or stays of any kind. In the opinion of many, this type of construction will be largely adopted for the commercial aeroplane, but the principle is different from that adopted by the majority of French manufacturers, who seek either to increase the carrying power of their machines or to obtain a higher speed, in the one case by augmenting the wing area without sufficient attention to the problem of securing a greater lift per unit of surface by a scientific study of the most suitable wing sections, and in the other case by increasing the engine power. If speed is to be a primary consideration with due regard to the factor of safety, there is much to be said for the French methods. Certainly, the French aeroplanes were generally of excellent construction, and in most cases they were of the biplane type, with two or four engines. One of the best was the Blériot, designed to carry twenty passengers, and fitted with four Hispano-Suiza engines in tandem on each side of the body. The Latecoere machines are employed in the France-Morocco service, and the biplane exhibited was another imposing apparatus designed to carry twenty passengers. Its span is 24.60 m. and length 14.30 m., and it is stated to be capable of flying at a speed of 200 kiloms. an hour. There are three engines, giving a total of 1000 horse-power, one in front of the body and the others on each side. The huge Farman was largely a copy of the Handley-Page. On account of the dimensions of most of the machines, the number of exhibits was necessarily restricted, despite the vast area of the Grand Palais. In the construction of aeroplanes there is an increasing tendency to employ metals, but this is being done with considerable hesitation through the difficulty of being able to place complete reliance upon the resistance and homogeneity of the light metals available for the purpose. As regards new developments there was little beyond the Sanchez-Besa aeroplane, with inclined lattice planes, and the somewhat complicated Pescara helicopter, which is reported to have given encouraging experimental results, while in aeronautics a novel exhibit was a model of the Vaugean airship, built up with a considerable number of rigid cells from which the air is partially exhausted to obtain a variable lifting force. It is stated that an airship on this principle is under construction.

Aviation Engines.

So far as aeroplane construction is concerned, sufficient advance has already been made to allow of such machines becoming a commercial success, if only it were not retarded by the problem of an economical and reliable engine. Until such an engine is available, the cost of flying will not permit of commercial services being run without the aid of subsidies, and as military aviation must depend upon the progress of the commercial side of flying, it follows that the various Governments cannot neglect to offer financial assistance wherever necessary. In this respect, France is probably in advance of other countries. As soon as aeroplane makers are supplied with engines developing much higher powers per unit of weight with lower fuel consumptions, it may be possible to make commercial services self-supporting. This was one of the leading questions discussed at the Congress, when it was pointed out that the chief impediment was the limitation of the existing metals, and it was proposed that an international arrangement should be come to whereby a special series of metals should be supplied for engine and aeroplane construction, the manufacture of such metals to be under constant and close control in all its stages, from the product of the furnace to the time that it leaves the rolling mills. As a further security it was proposed to come to some international agreement for determining the horse-power with a time factor, that is to say, the formula should be unified in all countries and the engine should be required to develop that power during a certain number of hours. At present, there are only four engines of French construction employed by aeroplane builders. All the rotary engines have been eliminated, and so long as the four-cycle principle is adopted, it follows that there is a limitation to the simplification of design, and weight can only be reduced with the aid of reliable metals offering greater resistance. This is a matter upon which the Congress is anxious to secure an international collaboration.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

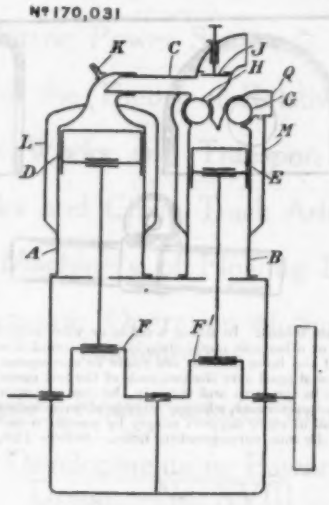
The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

170,031. May 11th, 1920.—REGENERATOR ENGINES, H. R. Ricardo, 21, Suffolk-street, Pall Mall, London, S.W. 1.

THIS engine is adapted to operate with liquid fuel, and is provided with a single working cylinder A, a single pump cylinder B, and a single regenerator passage C between these cylinders. The working and pump cylinders are of such dimensions that if the strokes of the pistons are equal the relation between the piston areas is as 2 for the working piston D to 1 for the pump piston E. The pistons D and E are respectively connected to cranks F and F¹, and the angle between the cranks is preferably 50 deg. with F¹ lagging behind F. The regenerator passage C extends between an opening in the head of the pump cylinder B and an opening in the head of the working cylinder A. All the valves are grouped on or near the head of the pump

Nº 170,031



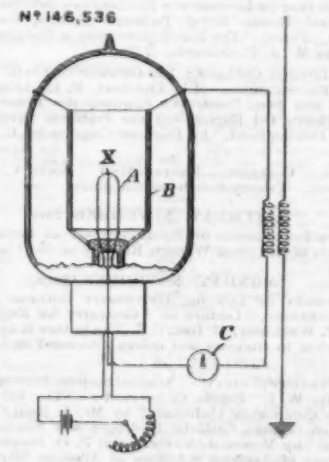
cylinder B. These valves comprise the inlet valve G, the delivery or transfer valve H, both of which are mounted directly on the head of the cylinder, and the exhaust valve J, which is arranged adjacent to or over the transfer valve H. The delivery end of the regenerator passage C terminates in the narrow part of a funnel-shaped extension of the head of the working cylinder. The narrow part of this extension practically forms the end of the regenerator passage and here is situated the fuel injection device K. The working cylinder is water-jacketed as at L and the pump cylinder is similarly water-jacketed as at M, the latter water jacket being carried up around the inlet and transfer valves G and H. The details of the engine are described and illustrated.—*October 11th*, 1921.

WIRELESS TELEGRAPHY.

146,536. July 5th, 1920.—IMPROVEMENTS IN OR RELATING TO APPARATUS FOR RADIO SIGNALLING, The Radio Corporation of America, of Woolworth Building, 223, New York.

The object of this invention is to provide means whereby the cold element of a thermionic valve used for detecting purposes may be connected with the indicator and a point upon the filament, the potential of which the cold element tends to assume, and thus, when a signal is received, the cold element

Nº 146,536

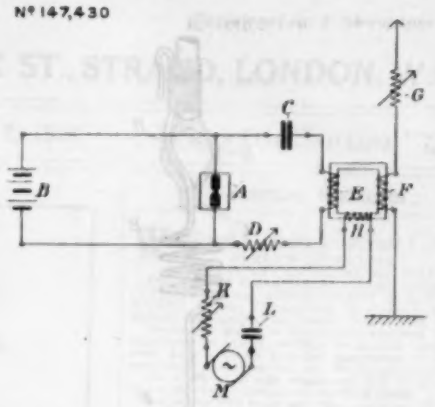


is made positive with respect to this point. The vacuum chamber contains a hot element A and a cold element B, with electrical connections extending to points outside the chamber. One terminal of the indicator C which may be a telephone, galvanometer or other suitable instrument, is connected in circuit through a coil to the cold element B, whilst the other terminal of the indicator is connected directly to a predetermined point X in the heated element A. The point X is preferably one of the hottest in the filament.—*October 9th*, 1921.

147,430. July 7th, 1920.—IMPROVEMENTS IN WIRELESS TELEGRAPH TRANSMISSION, Gesellschaft für Drahtlose Telegraphie, M.B.H., of 9, Tempelhofer Ufer, Berlin.

According to this invention, to obtain tone transmission with arc oscillations the arc generating circuit is coupled to the antenna circuit by a closed iron transformer, which electrically superimposes oscillations of audio-frequency. An arc A produced by a source of current B is connected with an oscillating circuit formed by a capacity C and inductance D, and including the

Nº 147,430



winding E of a transformer having an iron core. The secondary winding F is connected to the antenna containing the tuning arrangement G. The transformer is provided with a third winding H, which, if desired, is connected through the tuning devices K L, with the alternating-current generator M of corresponding tone frequency.—*October 7th*, 1921.

148,180. July 9th, 1920.—IMPROVEMENTS IN TRANSMITTERS OF HIGH FREQUENCY OSCILLATIONS, Gesellschaft für Drahtlose Telegraphie, M.B.H., of 9, Tempelhofer Ufer, Berlin.

For the purpose of preventing harmonics from reaching the antenna and being radiated therefrom a circuit is connected to the antenna in parallel with the high frequency generator so that the harmonics may be suppressed. T indicates the secondary coil of a transformer, to which the oscillation energy is supplied. The transformer is earthed and is connected to

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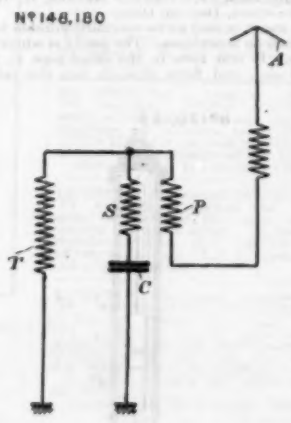
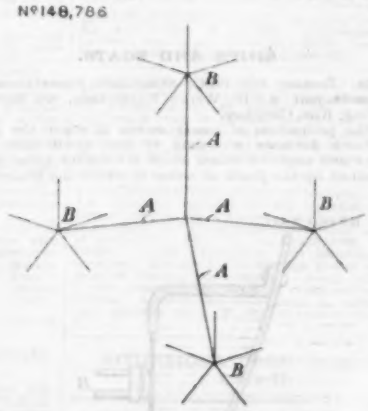


the antenna A. To prevent the harmonics from passing into the antenna a short circuit or rejector consisting of an inductance S and a capacity C is arranged in parallel with the transformer T. The rejector is so designed as to present a low resistance to the harmonics and a high resistance to the fundamental waves. A portion P of the inductance of the antenna is coupled to the inductance S of the rejector system.—*October 10th*, 1921.

148,786. May 21st, 1917.—IMPROVEMENTS IN GROUND CONNECTIONS FOR WIRELESS STATIONS, Professor Dr. Rudolf Goldschmidt, of 45, Linden Allee, Charlottenburg, Berlin.

This invention relates to a method of reducing the resistance of the earth connections used in wireless telegraphy and telephony. A A A are insulated conductors which conduct the

Nº 148,786

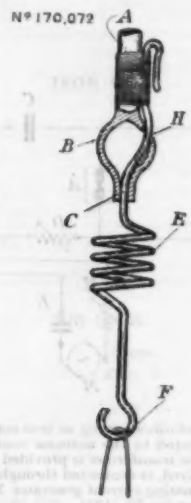


current to the leading points B B B, from each of which short conductor wires start and are arranged in the form of a star or other similar shape.—*October 10th*, 1921.

170,072. July 7th, 1920.—IMPROVEMENTS IN AND RELATING TO SUPPORTS FOR FILAMENTS USED IN THERMIONIC VALVES AND SIMILAR APPARATUS, Arthur Kenneth Macrorie, C.M.G., M.V.O., Captain, Royal Navy, Harold Morris-Airey, C.B.E., both of H.M. Signal School, Royal Naval Barracks, Portsmouth, Hampshire, and Stanley Robert Mullard, of 71, Standen-road, Southfields, London, S.W. 18.

The metal forming the tensioning spring E is continued at the end remote from the filament and hook F for a considerable distance. A supporting piece A of silica if the envelope is silica, and glass if the envelope is glass, has a spherical or bulbous-shaped hollow extension B fused on to its end. This extension

B has an opening C to receive the metal rod of the tensioning spring. The extension B is pierced by a side hole H, which permits the extra length of the spring to be pushed through it. This additional length of spring is threaded through the opening C, and through the hole H of the extension B, and

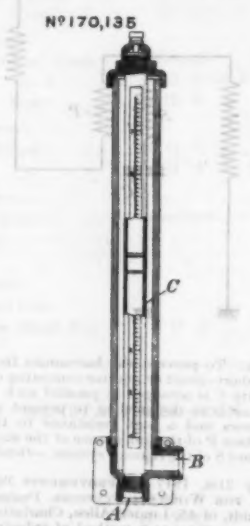


if necessary is then bound tightly to the portion A of the silica or glass support, as, for instance, by fine wire having a high melting point, such as molybdenum wire, or is twisted round the supporting piece to hold it in place.—*October 7th*, 1921.

TESTING AND MEASURING INSTRUMENTS.

170,135. July 26th, 1920.—Fluid Meters, R. W. Schroeder, 21, Olive-street, Dayton, Ohio.

This flow meter is said to be specially suitable for measuring the petrol used on aeroplanes. The petrol is admitted at A and leaves at B. It first rises in the stand-pipe C, which has a longitudinal slot, and flows through this slot into the space

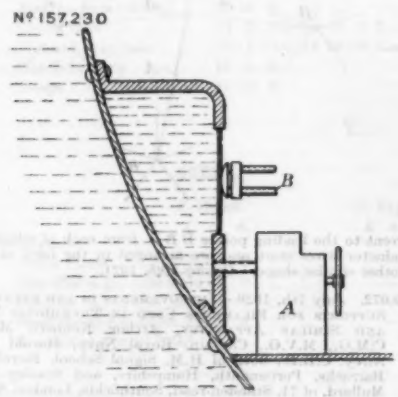


between the stand-pipe and an outer glass cover. This space communicates with B. A float is provided in the stand-pipe, and its height is a measure of the rate of flow.—*October 20th*, 1921.

SHIPS AND BOATS.

157,230. January 8th, 1921.—Submarine Signalling, Signal Gesellschaft m.b.H., Werke Ravensberg, am Habsburger Ring, Kiel, Germany.

In the production of sound waves in water the pressure amplitudes fluctuate according to this specification in the positive and negative senses about a constant value which is determined by the depth of water in which the transmitter is

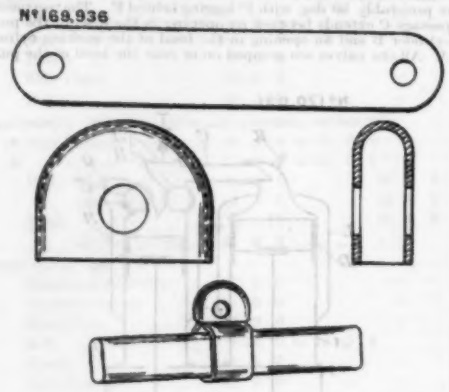


fixed. In the positive sense an upper limit for the pressure waves to be produced does not exist, but the negative pressure amplitudes cannot attain a greater absolute value than that corresponding to the constant water pressure. In practice it is not possible to go anything like so far with the pressure in the negative sense, because even with small negative amplitudes objections of various kinds become noticeable, as, for example, the formation of air and vapour. The invention provides a means whereby pressure amplitudes as high as desired in the positive and negative senses can be employed. The space nearest to the point where the sound arises, so far as in it the pressure amplitudes in their absolute amount approach the normal static pressure or exceed it, is maintained in a condition of artificial excess pressure. Several methods of applying the pressure are described. In the case illustrated herewith a pump A is used. B is the electro-magnetic sound transmitter.—*October 20th*, 1921.

MISCELLANEOUS.

169,936. November 22nd, 1920.—Improved Means for Fixing Electric Cables and Wires, Francis Charles Raphael, of 35, Chase Green-avenue, Enfield, Middlesex, and the Ediswan Electric Company, Limited, of 123–125, Queen Victoria-street, E.C. 4.

A thin strip of lead or other soft and pliable metal is provided with two holes, one near each end and a flat cap of other harder metal, such as iron, mild steel or brass, is provided with similar holes at the back and front to correspond with the holes in the soft metal strip, and the cap fits closely over the ends of the



strip when folded. In fixing a cable or wire with this device, the lead or other soft metal strip is bent around it and the two ends and the holes therein are made to correspond. The flat cap is now slipped over the two ends of the soft metal strip until the holes in the strip and those in the cap correspond. A suspender is thus formed, which is capable of being nailed or screwed to the wall or other support simply by passing a nail or a screw through the four corresponding holes.—*October 13th*, 1921.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. Lecturette: "Electro-magnetic Instruments; Problems in their Design and Construction," by Mr. G. F. Shotter. 8 p.m.

Institution of Production Engineers.—Institution of Mechanical Engineers, Storey's-gate, S.W. Paper: "Drawings and Production," by Mr. A. F. Guyler. (Lantern.) 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Dominions and Colonies and Indian Sections, joint meeting. "An Imperial Airship Service," by Mr. A. H. Ashbolt. 4 p.m.

The Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. Discussion, "Foundry Costs and Establishment Charges," to be introduced by Mr. Daniel Adamson. 7 p.m.

Institution of Locomotive Engineers: Scottish Centre.—Societies' Room, Royal Technical College, George-street, Glasgow. Paper, "The Locomotive from a Footplate Point of View," by Mr. J. P. Grassick. 7.30 p.m.

East London College: Department of Civil and Mechanical Engineering.—Mile End-road, E. 1. Lecture V., on "Diesel and Semi-Diesel Oil Engines, the Present Position of the Heavy Oil Engine and the Problems Involved in its Further Development," by Engineer-Commander B. W. Knott. 6 p.m.

King's College Engineering Society. — Holborn Restaurant. Twenty-fourth annual dinner.

SATURDAY, NOVEMBER 26TH.

Junior Institution of Engineers.—Visit to the Locomotive Sheds of the Great Western Railway at Old Oak Common. 2.30 p.m.

MONDAY, NOVEMBER 28TH.

University of London, University College: Faculty of Engineering.—Lecture on "Geometry for Engineers," by Mr. A. T. Walmisley, M. Inst. C.E. The lecture is open without fee or ticket to students and others interested in the subject. 5 p.m.

The Faraday Society.—Chemical Society, Burlington House, Piccadilly, W. 1. Papers to be read:—"The Effect of Cold Work on Commercial Cadmium," by Mr. J. Neill Greenwood; "Reaction between Cathodic Hydrogen and Nitrogen at High Pressures," by Messrs. J. N. Pring and E. O. Ransome; "The Electrolysis of Aqueous Solutions of Alkaline Nitrites with a Lead Anode and an Electrometric Determination of the Constitution of the Complex Anion Formed," by Mr. F. H. Jeffery; "An Inhibition Period in the Separation of an Emulsion," by Mr. T. C. Nugent; "Induced Reactions and Negative Catalysis," by Messrs. N. R. Dhar and N. N. Mittra. Dr. S. Judd Lewis and Miss F. M. Wood will exhibit and describe a new adjustable thermostat for all temperatures between 0 and 100 deg. Cent. 8 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture. "Process of Engraving and Etching," by Mr. Arthur M. Hind. Lecture I. 8 p.m.

Bradford Engineering Society.—Hall of Bradford Technical College. Lecture, "Wireless Telegraphy," by Mr. A. A. Liardet. 7.30 p.m.

Institution of Electrical Engineers: North-Eastern Centre.—Armstrong College, Newcastle. "Single and Three-phase Commutator Motors with Shunt and Series Characteristics," by Dr. S. P. Smith. Lantern lecture. 7.15 p.m.

TUESDAY, NOVEMBER 29TH.

Institution of Electrical Engineers: North-Western Centre.—Engineers' Club, Albert-square, Manchester. "The Cye Arc Process of Automatic Electric Welding," by Messrs. L. G. Steele and H. Martin. 7 p.m.

The Institution of Civil Engineers.—Great George-street, S.W. 1. Paper to be further discussed:—"The Indian Railway Gauge Problem," by Mr. Frederick George Royal-Dawson. 6 p.m.

Royal Institute of British Architects.—Galleries, 9, Conduit-street, W. 1. Public lecture, "American Architecture and Town Planning," by Mr. Raymond Unwin. 6 p.m.

WEDNESDAY, NOVEMBER 30TH.

Liverpool Engineering Society.—Royal Institution, Colquitt-street, Liverpool. "Modern Conceptions of Corrosion," by Mr. Wm. Ramsay. 8 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Preservation of Stone," by Mr. Noel Heaton. 4.30 p.m.

Thornycroft Engineering Society.—Works Canteen, Basingstoke. "Diesel Engines," by Mr. W. P. Batho. 7 p.m.

THURSDAY, DECEMBER 1ST.

Institution of Electrical Engineers.—Savoy-place, Victoria-embankment, W.C. 2. "The Cye Arc Process of Automatic Electric Welding," by Messrs. L. J. Steele and H. Martin. 6 p.m.

Royal Aeronautical Society.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture, "The Present State of Airship Development," by Major G. H. Scott. 5.30 p.m.

Royal Microscopical Society.—20, Hanover-square, W. The meeting announced for last Thursday, November 24th, has been postponed to Thursday, December 1st. 7.30 p.m.

East London College: Department of Civil and Mechanical Engineering.—Mile End-road, E. 1. Lecture VI. on "Diesel and Semi-Diesel Oil Engines, the Present Position of the Heavy Oil Engine and the Problems Involved in its Further Development," by Engineer-Commander B. W. Knott. 6 p.m.

Manchester Association of Engineers: Students' Section.—Chemical Lecture Theatre, Municipal College of Technology, Manchester. Lecture, "Hydraulic Turbines," by Dr. A. H. Gibson. 7 p.m.

FRIDAY, DECEMBER 2ND.

Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. Lecturette, "Notes on Maintenance of Electrical Accumulators," by Mr. B. L. Ludkin. 8 p.m.

The Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Manchester. Paper, "The Locomotive from a Footplate Point of View," by Mr. J. P. Grassick. 7 p.m.

The Sheffield Association of Metallurgists and Metallurgical Chemists.—Royal Victoria Hotel. Annual dinner. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper by Sir Eustace H. T. d'Eyncourt. 6.30 p.m.

Institute of Marine Engineers.—Hotel Cecil, Strand, W.C. 2. Annual dinner.

SATURDAY, DECEMBER 3RD.

Junior Institution of Engineers.—Visit to works of Messrs. Duroglass at Blackhorse-lane, Walthamstow. 2.30 p.m.

Institution of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. "Jar Ram Moulding Machines." 4 p.m.

MONDAY, DECEMBER 5TH.

University of London, University College: Faculty of Engineering.—Public lecture on "The Literature of Science," by Dr. A. Wolf. 5.30 p.m.

TUESDAY, DECEMBER 6TH.

Junior Institution of Engineers: Midland Section.—Chamber of Commerce, New-street, Birmingham. Presidential address by Mr. R. B. Askquith Ellis. 7 p.m.

Institution of British Foundrymen: Lancashire (Burnley) Branch.—Technical College, Burnley. "Foundry Problems," by Mr. W. H. Cook.

Institute of Marine Engineers.—The Minories, Tower Hill, E. 1. "Weather at Sea, including Clouds, Waves, &c.," by Sir D. Wilson-Barker. Lantern, ladies' night. 6.30 p.m.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. "The Early History of Copper and Bronze," by Mr. Geo. W. Mullins. 7.30 p.m.

WEDNESDAY, DECEMBER 7TH.

Institution of Railway Signal Engineers.—Midland Grand Hotel, St. Pancras. Resumed discussion on paper, "Three-position Signalling," by Mr. A. E. Tattersall. 6 p.m.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, S.W. 1. "Town Planning," by Mr. S. A. Hill-Willis. Lantern. 7 p.m.

THURSDAY, DECEMBER 8TH.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85–88, The Minories, Tower Hill, E. 1. "Casting in Metal Moulds," by Mr. S. A. E. Wells. 8 p.m.

FRIDAY, DECEMBER 9TH.

Institution of Mechanical Engineers.—Storey's-gate, Westminster. Informal meeting. Discussion, "Ball and Roller Bearings: Some Recent Types and Criticisms," continued from last session. 7 p.m.

West of Scotland Iron and Steel Institute.—24, Royal Technical College, George-street, Glasgow. "Modern Steam Generators for the Efficient Utilisation of Gaseous Fuels and the Efficient Recovery of Waste Heat," by Mr. Percy S. G. Kirk. 7 p.m.

TUESDAY, DECEMBER 13TH.

The Faraday Society.—Rooms of Chemical Society, Burlington House, W. 1. Annual general meeting. Address on "The Structure of Some Gaseous Molecules," by Professor A. O. Rankine. To be followed by a discussion. 7.45 p.m.

Lantern Slides.—Boving and Co., Limited, 56, Kingsway, W.C. 2, inform us that they have a complete new set of lantern slides showing examples of modern water turbines and hydro-electric installations, available for lecture purposes. The slides will be lent on request to responsible members of institutes, technical schools, &c.